

**EUR 122.e**

EUROPEAN ATOMIC ENERGY COMMUNITY - EURATOM

**TABLES OF CROSS-SECTIONS  
OF NUCLEAR REACTIONS WITH NEUTRONS  
IN THE 14-15 MeV ENERGY RANGE**

by

H. NEUERT and H. POLLEHN

**1963**



Report established by  
the University of Hamburg, Germany  
under the Euratom Contract No. 010-62-6 GEE D

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## TABLES OF CROSS-SECTIONS OF NUCLEAR REACTIONS WITH NEUTRONS IN THE 14-15 MeV ENERGY RANGE

### SUMMARY

During the last few years many measurements of nuclear reactions with neutrons ( $n, 2n$ ), ( $n, p$ ), ( $n, np$ ), ( $n, d$ ), ( $n, \text{He}^3$ ), ( $n, t$ ), ( $n, \alpha$ ) and ( $n, n\alpha$ ) in the energy range  $E_n = 14-15$  MeV have been carried out, so that a compilation of the cross-sections of these reactions seemed to be of general value. Thus, these tables of cross-sections will give a general picture of the measured values available, provide a basis for special theoretical considerations, and in some cases point up the urgency of making further investigations on more precise measurements in this field.

The tables are arranged as follows :

- I. Column I will mark each single measurement : the first number gives the atomic number and the second the mass of the target nucleus. The second number is left out if only the cross-section of the natural element has been measured. The small letter marks the type of reaction :

- a — ( $n, 2n$ ) reaction
- b — ( $n, p$ ) reaction
- c — ( $n, np + n, pn + n, d$ ) reaction
- d — ( $n, p + n, pn$ ) reaction
- e — ( $n, np$ ) or ( $n, nd$ ) reaction
- f — ( $n, d$ ) or ( $n, \text{He}^3$ ) reaction
- g — ( $n, p + n, pn + n, np + nd$ ) reaction
- h — ( $n, t$ ) or ( $n, 2p$ ) or ( $n, tn$ ) reaction
- i — ( $n, \alpha$ ) reaction
- k — ( $n, n\alpha$ ) reaction

The following number indicates the measurements of the different authors in order of succession.

### II. References.

- III. Half-life used for the measurement. If the half-life has especially been remeasured, an index mark is given.

### IV. Neutron energy in MeV.

### V. Cross-section in mb and error.

- VI. Specification of the absolute measurement of neutron flux. In the case of relative measurements, the cross-section used for comparison is given.

### VII. Description of method.

- VIII. Sources of uncertainties which according to the author have been used for calculation of error given in column V.

## IX. Target used for experiments.

In many cases not all the details could be specified in the columns because the publications do not contain though all the information necessary for columns III through IX.

It is obvious that two methods were mainly used for the determination of cross-sections :

- 1) Registration of the particles emitted in the reaction (nuclear plates, telescope);
- 2) Measurement of  $\beta$ - and  $\gamma$ -ray activities of the targets after irradiation by the neutrons.

For comparison of the results of different authors the following items must be observed :

- a) Method 1) does not permit of any discrimination between  $(n, p\gamma)$ - and  $(n, pn)$  or between  $(n, \alpha\gamma)$ - and  $(n, \alpha n)$ -reactions.
- b) By method 2) the reactions  $(n, np)$ ,  $(n, pn)$  and  $(n, d)$  cannot be separated.
- c) For a determination of cross-sections by method 2) it is necessary to know the intensities and the energies of all the  $\beta$ - and  $\gamma$ -rays emitted from the residual nuclei. For many nuclei the decay scheme is not known precisely. As a result of this, some errors may appear in the calculation of the cross-section from the radioactivities measured. But even by using equal decay schemes considerable differences in the results may still arise according to the method applied (measurement of total  $\beta$ -ray-activity, measurement of definite  $\gamma$ -energies in photopeaks, measurement of the total  $\gamma$ -activity, counting of positron annihilation radiation by coincidences).
- d) As in many publications not all the sources of uncertainties were thoroughly examined for a calculation of the errors, a comparison of the errors quoted by different authors can be made with some reserve only (see VIII). If quoted in the publications column V indicates whether the error given is the mean (mostly) or the probable error.
- e) Though a large number of results was compiled, it will still be difficult to make more precise statements on the quality of the single measurements. If there are several results available for one reaction at equal neutron energies it can be concluded from the tables which value could be used as an average. In the following we have considered some important reactions frequently used for comparison or relative measurements.

## CROSS-SECTIONS OF SOME REACTIONS FREQUENTLY USED FOR COMPARISONS AND RELATIVE MEASUREMENTS

Some reactions frequently used as a basis for relative measurements of cross-sections are given below. The individual results cannot be used without detailed examination to find out the most probable values of the cross-sections. In some cases however values can be found which may within certain limits represent a usable mean cross-section. It will in general and with all respect to the older experiments be reasonable to give more consideration to the newer results because the methods have been improved considerably; the results from nuclear plate and telescope measurements in particular may mostly include higher errors, because of the lower statistics, for instance. It will be easier to carry out the measurements of the induced radioactivity with improving accuracy. Furthermore, the energy dependence

of the cross-sections has to be considered if the measurements extend to a larger range of energy (between 12 and 20 MeV, for instance).

1)  $\text{Li}^6(n, \alpha) \text{H}^3$

Though careful measurements were carried out early on by Kern (K58 I) we should like to give priority to the values of Ribe (R52), Frye (F54) and Pollehn (P61 II) which concur fairly closely

$$\sigma = 26 \text{ mb at } 14.1 \text{ MeV};$$

2)  $\text{O}^{16}(n, p) \text{N}^{16}$

As the scattering of the values given for  $E_n = 14.5$  MeV is relatively low, a mean value of  $\sigma = 40$  mb is proposed;

3)  $\text{Al}^{27}(n, p) \text{Mg}^{27}$

At the energy  $E_n = 14.1$  MeV nearly all values join to give

$$\sigma = 81 \text{ mg.}$$

The values for  $E_n = 14.8$  MeV are more scattered, but they all come from relative measurements;

4)  $\text{Al}^{27}(n, \alpha) \text{Na}^{24}$

It is important to remember that the cross-sections of this reaction slowly decrease from 14 to 15 MeV. For  $E_n = 14.1$  MeV the values accumulate to

$$\sigma = 121 \text{ mb},$$

though recent results by Prestwood (P61 I; P61 IV) gave a value which is 6 mb higher. At 14.8 MeV the results of different authors meet at 114 mb;

5)  $\text{Fe}^{56}(n, p) \text{Mn}^{56}$

In this case the results at 14 to 15 MeV are widely scattered, so that it will be necessary to consider further measurements. Averaging several results yields a value of

$$\sigma = 114 \text{ mb at } 14.3 \text{ MeV};$$

6)  $\text{Cu}^{63}(n, 2n) \text{Cu}^{62}$ .

Although this reaction is frequently used for comparison, the different results are astonishingly far from uniform. A mean value is about

$$\sigma \approx 500 \text{ mb at } E_n = 14.1 \text{ MeV};$$

7)  $\text{Cu}^{65}(n, 2n) \text{Cu}^{14}$

Only a scarce number of absolute measurements is available. A mean value of about  $\sigma \approx 930$  mb is not yet sufficiently reliable.

On the basis of the more recent experiments by Prestwood (P61 I; P61 IV) on  $\text{Al}^{27}(n, \alpha)$ , this value should be lower about 20 mb.

From all reactions considered here the values of  $\text{Al}^{27}(n, \alpha)$  appear most accurate (about  $\pm 3\%$ ); for the other reactions deviations of 5 to 8% from the values suggested here should be allowed.



I

II

III

IV

V

VI

VII

VIII

IX

## D E U T E R I U M

### $D^2(n, 2n) H^1$

1-2a1	A58 II	—	14.1	$200 \pm 20$	abs. : $\alpha$ -from $T(d,n)$ 11e <sup>4</sup>	Pulsed neutron source of 2.5 $\mu$ sec duration. Detection of double pulses in a cadmium loaded liquid scintillator of 40'' length and 40'' o. The targets were in a hole of the scintillator	Standard deviation contains: stat. ( $\sim 8\%$ ), calibr. (3.4 %), neutron flux (4 %)	Several thin discs CD <sub>2</sub>
1-2a2	H60	—	—	$190 \pm 19$	—	—	—	—

## L I T H I U M

### $\text{Li}^6(n, p)$

3-6b1	B53 I	—	14.1	$6.7 \pm 0.8$	abs. : $\alpha$ -from $T(d, n) \text{He}^4$	$\beta$ -activity, $2\pi$ geometry prop. - counter. Calibration by the $\text{Cu}^{62}$ activity from $\text{Cu}^{63}(n, 2n) \text{Cu}^{62}$ with $\sigma_{\text{Cu}^{63}(n, 2n)} = 350$ mb at 14.1 MeV (cf. 29-63a). Decrease of the activity was recorded with a time-analyser	Standard deviation contains : statistics, calibration, $\sigma_{\text{Cu}^{63}(n, 2n)}$ , neutron flux	Isotopically enriched Li-foils : $\text{Li}^6(90.94\%)$ 420 mg/cm <sup>2</sup> ; $\text{Li}^7(99.90\%)$ 510 mg/cm <sup>2</sup>
3-6b2 diff.	F54	—	14	$6 \pm 2$ $d\Omega = 4\pi$	abs. : $\alpha$ -from $T(d, n) \text{He}^4$	Nuclear plate	Deviation contains : statistics neutron flux (4%) geometry (1.55%) separation of particle groups (<7%)	Isotop. enriched Li foils $\text{Li}^6$ (90.9%) $\text{Li}^7$ (99.9%) thickness <10 mg/cm <sup>2</sup>

### $\text{Li}^6(n, d) \text{He}^5$

3-6e1 diff.	F54	—	14	$89 \pm 10$ $d\Omega = 0^\circ - 169^\circ$	cf. 3-6b2
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### $\text{Li}^6(n, d) \text{He}^{5m}$

3-6e1m	F54	—	14	$77 \pm 9$ $d\Omega = 0^\circ - 169^\circ$	cf. 3-6b2
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### $\text{Li}^6(n, t) \text{He}^4$

3-6h1	R52	—	14.2	$26 \pm 3.6$	—	$\text{Li}^6$ in prop. - counter. Energy spectrum was recorded with a multi-channel analyser	—	With $\text{Li}^6$ enriched Li-foil
3-6h2 diff.	F54	—	14	$26 \pm 4$ $d\Omega = 4\pi$	cf. 3-6b2			

\*1 Also measured for  $12,5 \text{ MeV} \leq E_n \leq 18,3 \text{ MeV}$

\*<sup>2</sup> Also measured for  $E_n = 2.6$  MeV

\*<sup>3</sup> Also measured for  $4.4 \text{ MeV} \leq E_n \leq 14 \text{ MeV}$

\*<sup>4</sup> Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Li}^7(n, t) \text{ He}^5$								
3-7h1 diff.	F54	—	14	$55 \pm 8$ $d\Omega \leq 0^\circ - 169^\circ$		cf. 3-6b2		
$\text{Li}^7(n, tn) \text{ He}^4$								
3-7h2 diff.	R56 III	—	$14^{*1}$	$300 \pm 40$	abs. : proton recoils in normal emulsions	Nuclear plates with Li- loaded emulsions	—	Element

\*1 Also measured for  $4.4 \text{ MeV} \leq E_n \leq 14 \text{ MeV}$

## B E R Y L L I U M

### $\text{Be}^9(n, 2n) \text{Be}^8$

4-9a1	A58 II	—	14.1	$540 \pm 40$	—	cf. 1-2a1	—	—
4-9a2 diff.	R57	—	14.1	$420 \pm 70$ $E_n > 0.5 \text{ MeV}$ $d\Omega = 4\pi$	abs. $\alpha$ -from $T(d, n) \text{He}^4$	Nuclear plate; plates ar- rangd cyl. around a cyl. target. Only the recoil protons were recorded	Estimated total error	Element, cylinder
4-9a3	H60	—	—	$520 \pm 40$	—	—	—	—
4-9a4 diff.	M61 III	—	14.1	a) $540 \pm 70$  b) $4\pi \left[ \frac{d\sigma}{d\Omega} \right] = 480 \pm 9$ means for $0 = 0^\circ$ , $20^\circ$ , $45^\circ$ , $65^\circ$ , $90^\circ$ , $105^\circ$ , $120^\circ$	—	a) Be-powder mixed with the emulsion of a nuclear plate  b) Metallic Be cyl. sur- rounded by several plates	—	Powder $20 \text{ mg/cm}^3$  Metallic Be

### $\text{Be}^9(n, \alpha) \text{He}^6$

4-9i1	B53I	$0.83 \pm 0.03^*$	I4.1	$10 \pm 1$	—	cf. 3-6b1	—
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\* Measured by the authors

I

II

III

IV

V

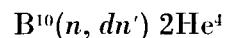
VI

VII

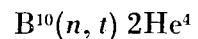
VIII

IX

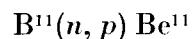
## BORON



5-10el diff.	F-56	—	14.1* <sup>1</sup>	$128 \pm 19$	—	Nuclear plate with $B^{10}$ loaded emulsion	—	—
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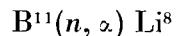


5-10h1	F-56	—	14.1* <sup>1</sup>	$102 \pm 17$	—	cf. 5-10e <sub>1</sub>	—	—
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5-11b1	K-61I	—	$14.5 \pm 0.8$	$3.2 \pm 0.4$	rel. : cf. 29-63a <sub>a</sub> $Cu^{63}(n, 2n) = 556 mb$	cf. 13-27b4	Powder thin target
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5-11b2	K-62	13.6 sec	$14.8 \pm 0.4$	$3.3 \pm 0.6$	rel. : cf. 29-33a $Cu^{63}(n, 2n) = 507 mb$	<i>a)</i> $\beta$ -activity $2\pi$ geometry (corrections cf. 13-27 <i>i</i> ) <i>b)</i> $\gamma$ -activity, measuring of the area under the photo-peak with a $3'' \times 3''$ NaI crystal	Probable total error	Powder thin target
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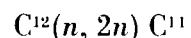
5-11i1 diff.	A56	—	$14.7 \pm 0.68^{*2}$	$30.9 \pm 6.3$	abs. : $\alpha$ -from $T(d, n) He^4$	Nuclear plate with $B^{11}$ loaded emulsion	Total error	$B^{11}$ -powder
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5-11i2	H54	0.88 sec	14	$\sim 30$	—	$BF_3$ -counter. Measuring of the $\alpha$ from $Be^8$ after the $\beta$ -decay of $Li^8$	—	—
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\*<sup>1</sup> Also measured for  $6 \text{ MeV} \leq E_n \leq 20 \text{ MeV}$

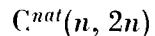
\*<sup>2</sup> Also measured for  $12.6 \text{ MeV} \leq E_n \leq 20 \text{ MeV}$

## C A R B O N

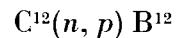


6-12a1      B61 II  
6-12a2      B52

Only rel. measurement of the excitation function\*<sup>1</sup>  
cf. 29-63a4 \*<sup>4</sup>



6- a2      A58 II      —      14.1      6 ± 6      cf. 1-2a1



6-12b1	K59 I	$18.87 \pm 0.50^{*2}$ msec	$14.92 \pm 0.48^{*3}$	$1.93 \pm 0.25$	rel. : cf. 3-6h4 $\text{Li}^6(n, t) = 26.5 \text{mb}$ for $E_n = 15 \text{ MeV}$	Pulsed neutron source, 7 pulses/sec; 1 msec duration. Counting between pulses. The pulse height distribution was recorded with a 100 channel and the total counts with a 9 channel time analyser	Total error	
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Plastic - scintillator  
served as a carbon  
containing target and  
permitted counting  
the  $\beta$  as a  $4\pi$  counter

■

\*<sup>1</sup> Measured from threshold to 37 MeV

\*<sup>2</sup> Measured by the authors

\*<sup>3</sup> Also measured for  $14.92 \text{ MeV} \leq E_n \leq 17.5 \text{ MeV}$

\*<sup>4</sup> Measured from threshold to 27 MeV

## N I T R O G E N

### $N^{14}(n, 2n) N^{13}$

7-14a1	P53	9-9 min	$14.5 \pm 0.35$	$5.67 \pm 0.85$	abs. : $\alpha$ -from $T(d, n)$ He <sup>4</sup>	$\beta$ -activity, prop. counter, Calibration with standard sources	Standard deviation, no systematic errors	Sugar, cylinder 3 cm $\sigma$ max. height 1,27 cm, but always more than half max. range of the $\beta$
7-14a2	R58 II	12.3 min	14	$\sim 8.5$	ref. : cf. 29-63a $Cu^{63}(n, 2n) = 500$ mb	$\beta^+$ activity 0.511 MeV annihilation radiation measured in coincidence with 2 scintillation counters (NaI crystals)	—	—
7-14a3	F-60*	—	$13.77 \pm 0.20$ $14.74 \pm 0.27$	$5.18 \pm 0.6$ $8.69 \pm 0.9$	rel. : cf. 3-6h4 $Li^6(n, t)$ He <sup>4</sup> = 28.1 mb Leaky-integrator used	$\beta^+$ activity. 0.511 MeV annihilation radiation measured in coincidence with 2NaI crystals. Calibration with Na <sup>22</sup>	Error contains : $\sigma Li^6(n, t) - 5\%$ , $d\sigma/d\Omega H^3(d, n) - 4\%$ , leaky integr. - 2 %, cal.- 5 %, stat. 1-15 % target position 2 %	$N_6 C_3 H_6$ , cylinder $7/16''$ o., 1'' height
7-14a4	B61 I	—	14.1	$4 \pm 1.2$	—	$\beta$ activity and $\gamma$ activity	Estimated total error	$NH_4NO_3$
7-14a5	A58 II	—	14.1	$19 \pm 10$	cf. 1-2a1	—	—	Melamine cf. 1-2a1
7-14a6	D54	10 min	14	$3.4 \pm 1$	abs. : $\alpha$ -from $T(d, n)$ He <sup>4</sup>	$\beta^+$ activity 0.511 MeV annihilation radiation measured in coincidence, counting-system calibrated with Na <sup>22</sup>	—	Liquid nitrogen
7-14a7	R61 II	$12.3 \pm 0.65$ min	$14.4 \pm 0.3$	$7.41 \pm 0.58$	rel. : cf. 29-63a $Cu^{63}(n, 2n) = 503$ mb	$\beta^+$ activity 0.511 MeV annihilation radiation measured in coincidence with 2NaI crystals. Calibration with Cu <sup>62</sup>	Mean total error	$NaN_3$ , variable thickness, 1 cm $\sigma$

\* Also measured for  $12.4 \text{ MeV} \leq E_n \leq 18 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
7-14a8	B61 II			cf 6-12a1*				
7-14i1	L52	—	14.1	~100	$N^{14}(n, \alpha) B^{11}$ rel. : cf. A50 $\sigma n-p$ scattering = 675 mb	In a cloud-chamber $N^{14}$ and $H^1$ in a known ratio	—	Gas

\* Also measured from threshold to 37 MeV

I	II	III	IV	V	VI	VII	VIII	IX
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## O X Y G E N

$$O^{16}(n, 2n) O^{15}$$

8-16a1	B61 II			cf. 6-12a1* <sup>1</sup>				
					O <sup>16</sup> (n, p) N <sup>16</sup>			
8-16b1	P53	7.3 sec	14.5 ± 0.35	49 ± 25		cf. 7-14a1		
8-16b2	L52	—	14.1	35		cf. 7-14i1	for N <sup>14</sup> → O <sup>16</sup>	
8-16b3	M54	7.38 ± 0.05* <sup>2</sup>	14* <sup>3</sup>	89 ± 27	rel. : cf. 29-63a2 Cu <sup>63</sup> (n, 2n) = 510 mb	Stilben; 4 cm o ½ mm height. The counting efficiency for the β of Cu <sup>62</sup> was supposed to be the same as for the β of N <sup>16</sup>	Estimated total error	5 gr. H <sub>2</sub> O
8-16b4	K61 I	7 sec	14.5 ± 0.8	39 ± 3.9		cf. 5-11b1		Powder
8-16b5	D60 I	7.352 ± 0.009 sec cf. E59I	14.7 ± 0.1	39.2 ± 1.6	abs. proton recoil telescope	β-activity, 4π counter. Liquid-scintillator served as target and counter. Counting efficiency proved with Tl <sup>204</sup> (99.5 %). Activity measured with 2 multipliers switched in coincidence; γ-spectrum recorded with a calibrated NaI-crystal	Total error	Liquid-scintillator : Dioxane (383 gr.) Naphthalene (37.5 gr.), PPO (37.5 gr.), POPOP (0.010 gr.)
8-16b6	S61 I	7.35 sec.	14.4	34 ± 6	abs. : proton recoil telescope	β-activity, liquid-scintillator served as target and counter	—	Liquid-scintillator
8-16b7	K62	7.4 sec	14.8 ± 0.4	38.2 ± 5	rel. : cf. 29-63a Cu <sup>63</sup> (n, 2n) = 507 mb	cf. 5-11b2		

\*<sup>1</sup> Measured from threshold to 37 MeV

\*<sup>2</sup> Measured by the authors

\*<sup>3</sup> Measured also for 12 MeV ≤ E<sub>n</sub> ≤ 18 MeV

I	II	III	IV	V	VI	VII	VIII	IX
8-16 <i>f</i> 1	L52	—	14.1	~15	$O^{16}(n, d) N^{15}$	cf. 7-14 <i>i</i> 1		
8-16 <i>i</i> 1	L52	—	14.1	~310	$O^{16}(n, z) C^{13}$	cf. 7-14 <i>i</i> 1		

## FLUORINE

### $F^{19}(n, 2n) F^{18}$

9-19a1	P53	$1.8h$	$14.5 \pm 0.35$	$60.6 \pm 8$	cf. 7-14a1	CaF <sub>2</sub> , NaF cf. 7-14a1
9-19a2	R58 I	$1.85h$	14	51.3	cf. 7-14a2	
9-19a3	B61 I	—	14.1	$50 \pm 15$	cf. 7-14a4	CF <sub>2</sub>
9-19a4	A58 II	—	14.1	$62 \pm 8.7$	cf. 1-2a1	CF <sub>2</sub>
9-19a5	R61 II	$1.85 \pm 0.04^{*1}$	$14.4 \pm 0.3$	$51.9 \pm 3.8$	cf. 7-14a7	CF <sub>2</sub>
9-19a6	B61 II		cf 6-12a1*2			

### $F^{19}(n, p) O^{19}$

9-19b1	P53	30 sec	$14.5 \pm 0.35$	$135 \pm 47$	cf. 7-14a1	CaF <sub>2</sub> , NaF cf. 7-14a1
9-19b2	K61 I	—	$14.5 \pm 0.8$	$16.5 \pm 2$	rel. : cf. 13-27b5 $Al^7(n, p) = 87 \pm 8$ mb	AlF <sub>3</sub> , CF <sub>2</sub>
9-19b3	K62	29 sec	$14.8 \pm 0.4$	$14.3 \pm 3.5$	cf. 5-11b2	

### $F^{19}(n, \alpha) N^{16}$

9-19i1	K61 I	—	$14.5 \pm 0.8$	$57 \pm 7$	cf. 5-11b2	AlF <sub>3</sub> -powder CF <sub>2</sub> , thin target
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\*1 Measured by the authors

\*2 Also measured from threshold to 37 MeV



## S O D I U M

### $\text{Na}^{23}(n, 2n) \text{ Na}^{22}$

11-23a1	P55	$2.6y$	$14.1 \pm 0.2$	$13.8 \pm 2.2$	rel. : $\text{Al}^{27}(n, \alpha) = ?$ Sandwich-method	$\beta$ -activity ; $4\pi$ prop. counter calibrated with $\text{Na}^{22}$ . Chemical separation	2x mean deviation from 6 measurements	NaF; after chem. separation $\text{NaCl}$ (30-80 mg)
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### $\text{Na}^{23}(n, p) \text{ Ne}^{23}$

11-23b1	P53	40 sec	$14.5 \pm 0.35$	$33.9 \pm 15$		cf. 7-14a1		NaCl
11-23b2	B60	40 sec	$14.1 \pm 0.1$	$9 \pm 4$	rel. : cf. 53-127a $\text{I}^{27}(n, 2n) = 1200 \text{ mb}$	$\beta$ -activity, NaI crystal served as target and counter	Stat. error	NaI crystal
11-23b3	M61 II	—	14.8	$29 \pm 2.9$		cf. 11-23i2		
11-23b4	W61 II	37.6 sec	No measurements for* $14 \text{ MeV} \leq E_n \leq 15 \text{ MeV}$		abs. : proton-recoil-spectrometer. Leaky integrator	$\beta$ -activity, $1\frac{1}{2}'' \times 1\frac{1}{2}''$ NaI crystal served as target and counter	—	NaI crystal

### $\text{Na}^{23}(n, p) \text{ Ne}^{23} + \text{Na}^{23}(n, pn) \text{ Ne}^{22}$

11-23d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) $57 \pm 20$ b) $50 \pm 20$	rel. : cf. 26-54d3 $\text{Fe}^{64}(n, p) = 395 \text{ mb}$	Shielded nuclear plate surrounded by several targets arranged in a circle of 8 emØ. Only protons with $0 \sim 120^\circ$ counted. Separation of $n,p$ - and $n,np$ -processes by stat. theory with level densities : a) $\rho \sim \exp(-E/T)$ b) $\rho \sim \exp(2(aU)^{1/2})$ Probably the cross-sections contain $n,d$ -processes	Deviation contains : stat. error ; separation of $n,p$ - and $n,np$ -processes	6 targets of $2 \times 1 \text{ cm}^2$ and 6-40 mg/cm <sup>2</sup> thickness
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\* Measured for  $4 \text{ MeV} \leq E_n \leq 19 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Na}^{23}(n, \gamma) \text{ F}^{20}$								
11-23 <i>i</i> 1	B60	12 sec.	14.1 $\pm$ 0.1	29 $\pm$ 10	rel. : cf. 53-127 <i>a</i> $\text{P}^{27}(n, 2n) \approx 1200mb$	$\beta$ -activity NaI-crystal served as target and 4 <i><math>\pi</math></i> counter	Stat. error	NaI-crystal
11-23 <i>i</i> 2	M61 II	—	14.8	222 $\pm$ 22	rel. : cf. 29-63 <i>a</i> 3 $\text{Cu}^{63}(n, 2n) \approx 556mb$ Sandwich-method	$\beta$ -activity 2 <i><math>\pi</math></i> geometry, prop. counter, Calibration with standard sources	Mean deviation of the single experimental points	Powder or foils
11-23 <i>i</i> 3	W61 II	10.7 sec.	No measurements for* 14 MeV $\leq E_n \leq$ 15 MeV		cf. 11-23 <i>b</i> 4			

\* Measured for 4 MeV  $\leq E_n \leq$  19 MeV

## M A G N E S I U M

### $Mg^{24}(n, p) Na^{24}$

								Element
12-24b1	P53	15h	—	$14.5 \pm 0.35$	$191 \pm 35$		cf. 7-14a1	
12-24b2	D60 II	—	—	$15 \pm 0.4$	$203 \pm 11$		cf. 26-56b1	
12-24b3	B61 V	—	—	14	$190 \pm 10$	rel. : cf. 16-32b2 $S^{22}(n, p) = 254mb$	Activation method	—
12-24b4	K59 III	—	—	$13.03 \pm 0.2$	$219 \pm 26$		cf. 14-28b2	
12-24b5	C56	12h	—			$\beta$ -activity measured with 3 uncalibrated geiger-counters. The excitation curves were fitted at 14.5 MeV with the cross-section for the same reaction found by P53* <sup>1</sup>		
12-24b6	I61	—	—	14.00* <sup>2</sup> 14.10 14.50 14.90	198 ± 30 200 ± 30 180 ± 27 173 ± 24	—	$\gamma$ -activity measured with a 4" diameter by 4" long NaI crystal	Uncertainties primarily involve : neutron flux calibration of the NaI crystal
12-24b7	G61 IV	—	—	14.00* <sup>3</sup> 14.50 14.90 15.00	185 ± 15 174 ± 14 170 ± 12 170 ± 12	—	—	—

### $Mg^{24}(n, p) Na^{24} + Mg^{24}(n, pn) Na^{23}$

12-24d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} =$ a) $118 \pm 16$ b) $110 \pm 16$		cf. 11-23d1		
12-24d2 diff.	C60 I	—	14.5	$4\pi \left[ \frac{d\sigma}{d\theta} \right] = 285 \pm 20$ means for $0 \approx 62^\circ$ , $75^\circ$ , $95^\circ$ , $138^\circ$ , $162^\circ$ and $d\theta = 10^\circ$		cf. 16-32d2		

\*<sup>1</sup> Measured for  $12.5 \text{ MeV} \leq E_n \leq 17.5 \text{ MeV}$

\*<sup>2</sup> Also measured for  $12.00 \text{ MeV} \leq E_n \leq 19.50 \text{ MeV}$

\*<sup>3</sup> Also measured for  $12.6 \text{ MeV} \leq E_n \leq 17.1 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
$Mg^{24}(n, p) Na^{24m}$								
12-24blm	G59 1	20 msec*	14.5	$80 \pm \sim 36 - 40$	rel.: cf. 29-63a $Cu^{63}(n, 2n) = 500mb$	Pulsed neutron source, 1 pulse/sec, 1.3 msec duration: $\gamma$ -activity measured between pulses with an experimentally calibrated NaI crystal. a) Total spectrum was recorded with a multi-channel pulse height analyser b) Decrease of the photo-peak was measured with a time-analyser (Channel width $0.1\text{-}4.10^{-5}$ sec)	Estimated total error	Thick target; 4.5 or 10 cm $\varnothing$
$Mg^{25}(n, p) Na^{25}$								
12-25b1	P53	60 sec	$14.5 \pm 0.35$	$44.9 \pm 18$		cf. 7-14a1		Element
12-25b2	N58	60 sec	$14.8 \pm 0.8$	$60 \pm 10$	rel.: cf. 8-16b3 $O^{16}(n, p) = 89mb$	cf. 12-26b1		
$Mg^{25}(n, p) Na^{25} + Mg^{25}(n, p) Na^{24}$								
12-25d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) $67 \pm 10$ b) $63 \pm 10$		cf. 11-23d1		
$Mg^{26}(n, p) Na^{26}$								
12-26b1	N58	$1.04 \pm 0.03$ sec*	$14.8 \pm 0.8$	$50 \pm 5$	rel.: cf. 8-16b3 $O^{16}(n, p) = 89mb$	$\beta$ -activity counted with a plastic-scintillator	—	$MgO$ , natural and enriched $Mg^{26}O \neq 99\%$ cylinder 1-6 cm $\varnothing$ , 2-3 cm height

\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
					$Mg^{26}(n, p) Na^{26} + Mg^{26}(n, pn) Na^{25}$			
12-26d1	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) $27 \pm 7$ b) $27 \pm 7$		cf. 11-23d1		
					$Mg^{26}(n, \alpha) Ne^{23}$			
12-26i1	N58	$38.0 \pm 0.3$ sec*	$14.8 \pm 0.8$	$89 \pm 5$		cf. 12-26b1		
					$Mg^{nat}(n, p + n, pn + n, np + n, d) Na$			
12-g1 diff.	V57	—	14	$4\pi \left[ \frac{d\sigma}{d\Omega} \right] = 32 \pm 3.8$ means for $\theta = 30^\circ, 45^\circ, 60^\circ, 90^\circ, 120^\circ, 135^\circ, 150^\circ$ and $E_p < 6$ MeV	abs. : $\alpha$ -from $T(d, n) He^4$	Shielded CsI crystal in coincidence with $\alpha$ from $T(d, n)$ . $\alpha, \sigma$ probably contains $(n, \alpha)$ processes	—	Height : 2.5 MeV energy loss for 6 MeV protons ; calibration with a polyethylene foil
					$Mg^{nat}(n, p + n, pn) Na$			
12-d1 diff.	H62 III	—	$14.4 \pm 0.2$	$88 \pm 9$ means for $0^\circ \rightarrow 150^\circ$ in $30^\circ$ intervals and $E_p > 3$ MeV	abs. : neutron flux monitored by a $BF_3$ counter calibrated with a Ra-Be source and the $n, p$ -scattering	Telescope with 3 prop. counters and a CsI-crystal. Separation of $n, p$ - and $n, np$ -processes by stat. theory	—	—

\* Measured by the authors



I	II	III	IV	V	VI	VII	VIII	IX
A L U M I N U M								
$\text{Al}^{27}(n, 2n) \text{ Al}^{26m}$								
13-27a1m	M60			cf. 13-27b6*1				
					$\text{Al}^{27}(n, p) \text{ Mg}^{27}$			
13-27b1	P53	10 min	$14.5 \pm 0.35$	$52.4 \pm 14$		cf. 7-14a1		
13-27b2	F52	9.6 min	14.1	$79 \pm 5.5$	abs. : $\alpha$ from $T(d, n) \text{ He}^4$	$\beta$ -activity, 2 prop. counters 4 different geometries ( $4.5^\circ_0 : 13^\circ_0 : 23^\circ_0 : 45^\circ_0$ ): counters and geometries calibrated with standard sources. Scattering and absorption in the targets determined by measurements with targets of different thickness; extrapolation to thickness 0	Total error without uncertainties in the decay-scheme	Element, $\frac{1}{2}'' \otimes$ . Purity > 99 %
13-27b3	Y57	9.8 min	$14.1 \pm 0.15$	$82.2 \pm 6.6$	abs. : $\alpha$ -from $T(d,n) \text{ He}^4$ with ZnS counter	$\beta$ -activity, $2\pi$ and $4\pi$ geometry. Corrections for absolute $\beta$ counting were determinated a) by measurements in $2\pi$ and $4\pi$ geometry b) by measurements with targets of different thickness: extrapolation to thickness 0	Total error without systematic deviations	—
13-27b4	P59 I	$9.46 \pm 0.02$ min*2	$14.8 \pm 0.8$	$53 \pm 5$	rel. : cf. 29-63a3 $\text{Cu}^{63}(n, 2n) = 556 \text{ mb}$ Sandwich method	$\beta$ -activity, $2\pi$ geometry prop. counter. Corrections for absolute $\beta$ -counting computed (cf. N52 : B53 III; G51; B49; Z50; J50; W53; G57 I)	Maximal deviations of the single experimental points from the means	Element : discs 1.7-2.1 cm $\otimes$ thickness 3 mg/cm $^2$

\*1 Measured from threshold to 21 MeV

\*2 Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
13-27b5	K61 I	—	14.5 $\pm$ 0.8	87 $\pm$ 8	rel. : cf. 29-63a3 $Cu^{63}(n, 2n) = 556$ mb Sandwich method	cf. 27-59b1		Element and $Al_2O_3$ : thin target
13-27b6	M60	—	Rel. measurement. Excitation curve fitted at 14.1 MeV * <sup>1</sup>			$\gamma$ -activity: NaI crystal of 2.54 cm height and 3.81 cm $\varnothing$ . $\gamma$ -spectrum was recorded with a multi- channel-analyser	Rel. error: no sys- tematic deviations	Element: cylinder 2.5 cm height 5.08 cm $\varnothing$
13-27b7	K59 II	9.5 min	14.3 $\pm$ 0.5	115.5 $\pm$ 10	rel. : cf. 26-56b $Fe^{56}(n, p) = 110$ mb Sandwich method	$\beta$ -activity, prop. counter with a window of 4.5 mg/cm <sup>2</sup>	Stat. error, Other de- viations $\sim 10\%$	Powder 20 mg/cm <sup>2</sup> in tape of 9 mg/cm <sup>2</sup> , Purity $\sim 99.9\%$
13-27b8	P61 III	9.6 $\pm$ 0.3 min* <sup>2</sup>	14.1 $\pm$ 0.1	80.8 $\pm$ 4.5	rel. : cf. 3-6h5 $Li^6(n, t) = 25.8$ mb	$\gamma$ -activity NaI- well- crystal of 3" $\varnothing$ and 2" height, and a hole of 1" $\varnothing$ and 1" depth. Decrease of the total spectrum and of single $\gamma$ -lines recorded. Corrections for abs. $\gamma$ - counting anal. computed (cf. P61 VII). Decay- scheme : cf. S58	Standard total error	Element, powder in a plexiglass-cyl. of 1" $\varnothing$ and 1" height
13-27b9	M61 II	—	14.8	77 $\pm$ 7.7	rel. : cf. 29-63a3 $Cu^{63}(n, 2n) = 556$ mb or cf. 13-27i8 $Al^{27}(n, \alpha) = 117$ mb Sandwich method	$\beta$ -activity, 2 $\pi$ geometry prop.-counter. Corrections for abs. $\beta$ -counting com- puted and experim. deter- minated by standard sour- ces	Mean deviation of the experim. points	Powder or foils
13-27b10	D60 II	—	15 $\pm$ 0.4	59 $\pm$ 6		cf. 26-56b7		
13-27b11	H59	—	14.8	80.8 $\pm$ 10	—	$\gamma$ -activity, NaI crystal	—	—

\*<sup>1</sup> Also measured for 12 MeV  $\leq E_n \leq$  21 MeV

\*<sup>2</sup> Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
13-27b12	S61 II	$10.00 \pm 0.03$ min* <sup>1</sup>	$14.1 \pm 0.2$	$85 \pm 2.8$	abs. : $\alpha$ -from $T(d, n) \text{He}^4$	$\beta$ -activity, block of sandwiched targets: plastic- and target- foils served as counter and target. Calibration by standard sources	Stat. deviation	Foils
13-27b13	K62	9.5 min	$14.8 \pm 0.4$	$82 \pm 10$		cf. 5-11b2		
13-27b14	G61 IV	—	$14.35 \pm 0.1$ * <sup>2</sup> 14.4 $14.9 \pm 0.2$	$52 \pm 3$ $57 \pm 4$ $56.5 \pm 3$	—	—	—	—
$\text{Al}^{27}(n, p) \text{Mg}^{27} + \text{Al}^{27}(n, pn) \text{Mg}^{26}$								
13-27d1	A57 II	—	14.1	$70 \pm 14$	abs. : $\alpha$ -from $T(d, n) \text{He}^4$	Nuclear plate, separation of $n, p$ - and $n,np$ -processes by stat. theory. $\sigma$ probably contains $n,d$ -processes	Estimated total error	Isotopically enriched targets ; thickness 5-12 mg/cm <sup>2</sup>
13-27d2 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) $87 \pm 11$ b) $76 \pm 10$		cf. 11-23d1		
13-27d3 diff.	S60	—	14.1	$2 \frac{d\sigma}{d\Omega} = 90 \pm 18$ for $d\Omega = 0^\circ - 180^\circ$	abs. : proton recoil spectrometer	Direct measurement of the protons by a shielded CsI crystal. Approximately $2\pi$ geometry. Distance from target to crystal = 2 mm. Separation of $n,p$ - and $n,np$ -processes by stat. theory. Probably $\sigma$ contains $n, d$ -processes	Estimated total error	Isotopically enriched targets ; thickness $\sim 15$ mg/cm <sup>2</sup>

\*<sup>1</sup> Measured by the authors

\*<sup>2</sup> Also measured for  $13.2 \text{ MeV} \leq E_n \leq 17.8 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
13-27d4 diff.	G61 IIII	—	14.8 $\pm$ 0.8	$4\pi \left[ \frac{d\sigma}{d\theta} \right] =$ a) $89 \pm 8$ for the isotr. part b) $116 \pm 10$ for the total part, means for 10 angles between $0^\circ$ and $150^\circ$		cf. 28-58d4		Foils, thickness 7.1 mg/cm <sup>2</sup>
13-27d5 diff.	H62 III	—	14.4 $\pm$ 0.2	$93 \pm 10$ for $E_p > 2.8$ MeV $\text{Al}^{27}(n, np) \text{Mg}^{26}$		cf. 12-g1		
					$\text{Al}^{27}(n, np) \text{Mg}^{26}$			
13-27e1	A57 III	—	14.I	70 $\pm$ 14		cf. 13-27d1		
13-27e2 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} = 53 \pm 11$		cf. 11-23b4		
13-27e3 diff.	H62 III	—	14.4 $\pm$ 0.2	17 $\pm$ 6 for $E_p > 2.8$ MeV		cf. 12-g1		
13-27e4 diff.	G61 III	—	14.8 $\pm$ 0.8	$4\pi \left[ \frac{d\sigma}{d\theta} \right] = 157 \pm 15$ means for 10 angles between $0^\circ$ and $150^\circ$		cf. 28-58d4		
					$\text{Al}^{27}(n, p) \text{Mg}^{27} + \text{Al}^{27}(n, pn + n, np + n, d) \text{Mg}^{26}$			
13-27g1 diff.	V57	—	14	$4\pi \left[ \frac{d\sigma}{d\theta} \right] = 34 \pm 6$ means for $\theta = 30^\circ, 45^\circ, 60^\circ, 90^\circ, 120^\circ, 135^\circ, 150^\circ$ and $E_p > 6$ MeV		cf. 12-g1		
13-27g2 diff.	H57	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right] = 79 \pm 16$ means for $\theta = 30^\circ, 60^\circ, 90^\circ, 120^\circ, 150^\circ$ and $d\theta = 15^\circ$	abs. : recoil-protons in a nuclear plate	Nuclear plates cyl. arranged around the target	Estimated total error	Al-foils ; thickness 7.1 mg/cm <sup>2</sup>

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Al}^{27}(n, t) \text{Na}^{23}$								
13-27 <i>i</i> 1	P62	—	14.7	< 0.02	—	—	—	—
$\text{Al}^{27}(n, \alpha) \text{Na}^{24}$								
13-27 <i>i</i> 1	P53	15 <i>h</i>	$14.5 \pm 0.35$	$78.9 \pm 16$	cf. 7-14 <i>a</i> 1	—	—	—
13-27 <i>i</i> 2	F52	15 <i>h</i>	14.1	$135 \pm 9.5$	cf. 13-27 <i>b</i> 2	—	—	—
13-27 <i>i</i> 3	Y57	15.1 <i>h</i>	$14.1 \pm 0.15$	$120 \pm 14$	cf. 13-27 <i>b</i> 3	—	—	—
13-27 <i>i</i> 4	P59 I	$15.00 \pm 0.06 h^{*1}$	$14.8 \pm 0.8$	$114 \pm 7$	cf. 13-27 <i>b</i> 4	—	—	—
13-27 <i>i</i> 5	M60	—	—	cf. 13-27 <i>b</i> 6 <sup>*2</sup>	—	—	—	—
13-27 <i>i</i> 6	K59 II	15.0 <i>h</i>	$14.3 \pm 0.5$	$111 \pm 9$	cf. 13-27 <i>b</i> 7	—	—	—
13-27 <i>i</i> 7	K59 III	—	$14.2 \pm 0.4^{*3}$	$113 \pm 16$	rel. : cf. 3-6 <i>h</i> 4	$\gamma$ -activity, $3'' \times 3''$ NaI-	Deviation contains :	Powder, $3/4'' \otimes, 1/2''$
			$14.7 \pm 0.4$	$120 \pm 16$	$\text{Li}^6(n, t) \text{He}^4 = 28.1 \text{ mb}$	well-crystal with a hole of	neutron-flux : $\sim 7\%$	height
			$14.7 \pm 0.4$	$113 \pm 15$	for $E_n = 14.2 \text{ MeV}$	$3/4'' \otimes$ and $2''$ depth.	target position $\sim 3\%$	
					Leaky-integrator	Calibration (total counts)	stat. error $\sim 3-5\%$	
						with standard sources	calibration $\sim 6-9\%$	
13-27 <i>i</i> 8	S59 II	—	14.8 <sup>*4</sup>	$117 \pm 8$	rel. : $\text{U}^{238}$ fiss = ?	$\gamma$ -activity, NaI crystal	—	—
						exp. calibrated	—	—
13-27 <i>i</i> 9	P61 IV	—	$13.88 \pm 0.10^{*5}$	$128 \pm 6.4$	abs. : z-from	$\beta$ -activity, $2\pi$ geometry	—	—
			$14.09 \pm 0.10$	$127 \pm 6.4$	$T(d, n) \text{He}^4$	Corrections for absolute		
			$14.31 \pm 0.13$	$124 \pm 6.2$		$\beta$ -counting exp. determined		
			$14.50 \pm 0.20$	$120 \pm 6.5$		(cf. B59 I). Chemical		
			$14.68 \pm 0.26$	$118 \pm 5.8$		separation		
			$14.81 \pm 0.31$	$115 \pm 5.8$				
			$14.93 \pm 0.36$	$113 \pm 5.7$				

<sup>\*1</sup> Measured by the authors

<sup>\*2</sup> Also measured for  $12 \text{ MeV} \leq E_n \leq 21 \text{ MeV}$

<sup>\*3</sup> Also measured for  $13.0 \text{ MeV} \leq E_n \leq 15.7 \text{ MeV}$

<sup>\*4</sup> Also measured for  $6.2 \text{ MeV} \leq E_n \leq 8.3 \text{ MeV}$

<sup>\*5</sup> Also measured for  $7 \text{ MeV}$  and  $12.1 \text{ MeV} \leq E_n \leq 19.6 \text{ MeV}$

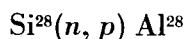
I	II	III	IV	V	VI	VII	VIII	IX
13-27 <i>i</i> 10	G58	—	14.1 $\pm$ 0.04	116 $\pm$ 5.3	abs.: $\alpha$ from $T(dn)$ He <sup>4</sup>	$\beta$ -activity, $2\pi$ and $4\pi$ geo- metry: corrections for abs. $\beta$ -counting exp. de- terminated (cf. B59 I)	Estimated total error	Element
13-27 <i>i</i> 11	K57	—	14.8	82 $\pm$ 16	abs.: $\alpha$ from $T(d,n)$ He <sup>4</sup>	Nuclear plate, Al- foils between the plates. Sep- aration of $\rho$ and $\alpha$ by the « temperature method » (cf. D51). Separation of $n,\alpha$ -; $n,n\alpha$ -and $n,\alpha n$ -processes	Estimated total error	Al foils of 1.8 mg/cm <sup>2</sup> thickness
13-27 <i>i</i> 12	D60 11	—	14.5 $\pm$ 0.4	116 $\pm$ 9	rel.: cf. 29-63a3 $Cu^{63}(n, 2n) = 556$ mb Sandwich-method	$\beta$ -activity, prop. counter	—	Thickness : 27 mg/ cm <sup>2</sup>
13-27 <i>i</i> 13	I61	—	No measurement for <sup>*1</sup> 14 MeV $\leq E_n \leq$ 15 MeV			cf. 12-24b6		
13-27 <i>i</i> 14	S62	—	14.6 $\pm$ 0.2 — 0.3	115 $\pm$ 2		cf. 37-87a1		
13-27 <i>i</i> 15	T60	—	13.9 <sup>*2</sup> 14.0 14.1 14.6 15.1	95 89 87 107 93	—	—	—	—
13-27 <i>i</i> 16	G61 IV	—	14 14.4 14.5 14.7 14.8	124 $\pm$ 6 116 $\pm$ 3 118 $\pm$ 5 115 $\pm$ 6 109 $\pm$ 3	—	—	—	—
$Al^{27}(n, \alpha) Na^{24m}$								
13-27 <i>i</i> 1m	G59 I	20 msec	14.5	40 $\pm$ 20		cf. 12-24b1m		

<sup>\*1</sup> Measured for 12.6 MeV  $\leq E_n \leq$  18 MeV

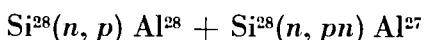
<sup>\*2</sup> Also measured for 8.2 MeV  $\leq E_n \leq$  15.1 MeV

I	II	III	IV	V	VI	VII	VIII	IX
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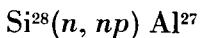
## S I L I C O N



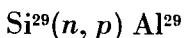
14-28b1	P53	2.4 min	$14.5 \pm 0.35$	$220 \pm 50$		cf. 7-14a1		
14-28b2	K59 III	—	$14.0 \pm 0.4^{*1}$	$440 \pm 57$		cf. 13-27i7		
			$14.2 \pm 0.4$	$365 \pm 29$				
			$14.7 \pm 0.4$	$340 \pm 37$				
			$15.0 \pm 0.4$	$303 \pm 30$				
14-28b3	C56	—			cf. 12-24b8*2			
14-28b4	F58 II	—	14	$\sim 380$	—	—	—	—



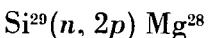
14-28d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} =$		cf. 11-23d1		
			a) $243 \pm 22$					
			b) $246 \pm 22$					



14-28e1	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} =$		cf. 11-23d1		
			$27 \pm 20$					



14-29b1	P53	6.7 min	$14.5 \pm 0.35$	$101 \pm 30$		cf. 7-14a1		
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14-29h1	B62 II	21.3 h	14.7	$\leq 0.50$	—	—	—	—
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\*1 Also measured for  $12.33 \text{ MeV} \leq E_n \leq 18.24 \text{ MeV}$

\*2 Measured for  $12.5 \text{ MeV} \leq E_n \leq 17.5 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
I4-30 <i>i</i> I	P53	10 min	14.5 $\pm$ 0.35	45.9 $\pm$ 25		cf. 7-14 <i>a</i> 1		
14- <i>d</i> 1 diff.	H62 III	—	14.4 $\pm$ 0.2 for $E_p > 2.9$ MeV	160 $\pm$ 16		cf. 12- <i>d</i> 1		

## P H O S P H O R U S

### $P^{31}(n, 2n) P^{30}$

15-31a1	R58 II	2.4 min	14	11.9		cf. 7-14a2
15-31a2	F60	—	$14.74 \pm 0.27^{*1}$	$8.7 \pm 2.7$		cf. 7-14a3
15-31a3	R61 II	$2.53 \pm 0.12$ min <sup>*2</sup>	$14.4 \pm 0.3$	$10.9 \pm 8.5$		cf. 7-14a7
15-31a4	K62	2.55 min	$14.8 \pm 0.4$	$8.9 \pm 1.2$	rel.: cf. 29-63a $Cu^{63}(n, 2n) = 507$ mb Sandwich-method	$\gamma$ -activity, measuring of Probable total error Powder the area under the photo- peak with a $3 \times 3''$ NaI crystal. Calibration with standard sources

### $P^{31}(n, p) Si^{31}$

15-31b1	P53	2.7h	$14.5 \pm 0.35$	$64.2 \pm 8.4$		cf. 7-14a1
15-31b2	F52	170 min	14.1	$91 \pm 9$		cf. 13-27b2
15-31b3	G58	2.65h	$14.1 \pm 0.04$	$85.5 \pm 7$		cf. 13-27i10
15-31b4	K62	2.65h	$14.8 \pm 0.4$	$82 \pm 10$		cf. 5-11b2

### $P^{31}(n, p) Si^{31} + P^{31}(n, pn) Si^{30}$

15-31d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) $184 \pm 14$ b) $114 \pm 14$		cf. 11-23d1
15-31d2 diff.	H62 III	—	$14.4 \pm 0.2$	$155 \pm 16$ for $E_p > 2.9$ MeV		cf. 12-d1

<sup>\*1</sup> Also measured for  $12.5 \text{ MeV} \leq E_n \leq 18 \text{ MeV}$

<sup>\*2</sup> Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
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$P^{31}(n, np) Si^{30}$								
15-31el diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ 163 $\pm$ 14			cf. 11-23d1	
15-31e2 diff.	H62 III	—	14.4 $\pm$ 0.2	70 $\pm$ 14 for $E_p > 2.9$ MeV			cf. 12-d1	
$P^{31}(n, d) Si^{30}$								
15-31f1 diff.	C60 II	—	14.5	14.5 $\pm$ 2.8	abs. : proton-recoil-telescope	Telescope ; 2 prop.-counters in coincidence with a CsI crystal and 1 prop. counter before the target in anticoinc. to the other counters	—	—
$P^{31}(n, \alpha) Al^{28}$								
15-31i1	P53	2.4 min	14.5 $\pm$ 0.35	146 $\pm$ 30			cf. 7-14a1	
15-31i2	K62	2.3 min	14.8 $\pm$ 0.4	153 $\pm$ 20			cf. 15-31a4	
15-31i3	G61 IV	—	13.9 $\pm$ 0.15*	119 $\pm$ 5			cf. 12-24b10	
			14.4 $\pm$ 0.12	117 $\pm$ 5				
			14.9 $\pm$ 0.1	116 $\pm$ 5				

\* Also measured for  $13$  MeV  $\leq E_n \leq 16.6$  MeV

## S U L P H U R

### $S^{32}(n, p) P^{32}$

I6-32b1	P53	$14d$	$14.5 \pm 0.35$	$369 \pm 44$		cf. 7-14a1	Element
16-32b2	A57 I	$14.3d$	$13.89 \pm 0.025^*$	$257 \pm 13$	rel. : $S^{32}(n, p) =$	$\beta$ -activity, $4\pi$ geometry,	Probable error
			$14.1 \pm 0.04$	$248 \pm 13$	$254 \pm 10$ mb for	prop. counter. Chemical	Element $1''\varnothing$ ; thick-
			$14.32 \pm 0.16$	$231 \pm 12$	$E_n = 14.10 \pm 0.04$ MeV	separation	ness = $3/32''$
			$14.53 \pm 0.26$	$225 \pm 12$	abs. : for $E_n = 14.10$ MeV		
			$14.70 \pm 0.29$	$220 \pm 11$	$\propto$ from $T(d, n) He^4$		
			$14.83 \pm 0.40$	$213 \pm 11$			
			$14.93 \pm 0.45$	$213 \pm 11$			
			$14.95 \pm 0.47$	$214 \pm 11$			

### $S^{32}(n, p) P^{32} + S^{32}(n, pn) P^{31}$

16-32d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} =$ a) $365 \pm 25$ b) $289 \pm 25$		cf. 13-23dI	
16-32d2 diff.	C60 I	—	14.5	$4\pi \left[ \frac{d\sigma}{d\theta} \right] = 109 \pm 10$ , means for $0 = 62^\circ$ , $75^\circ$ , $95^\circ$ , $138^\circ$ , $162^\circ$ and $d\theta = 10^\circ$		cf. 15-31f1	
16-32d3 diff.	E59 III	—	14.1	$185 \pm 30$ lower limit for $\sigma$ . $E_p > 5$ MeV	abs. : proton recoil telescope	Telescope ; 2 prop. counters in coincidence with a CsI	Element 31 mg/cm <sup>2</sup>

### $S^{32}(n, np) P^{31}$

16-32e1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} =$ $105 \pm 25$		cf. 11-23dI
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\* Also measured for  $1.59$  MeV  $\leq E_n \leq 14.95$  MeV

I	II	III	IV	V	VI	VII	VIII	IX
$S^{32}(n, d) P^{31}$								
16-32f1 diff.	C60 II	—	14.5	$14 \pm 4.2$			cf. 15-31f1	
$S^{32}(n, t) P^{30}$								
16-32h1	W62	—	$14.7 \pm 0.3$	$0.020 \pm 0.005$			cf. 29-63a1I	
16-32h2	P62	—	14.7	$< 0.02$	—	Counting of the tritium in a low-background prop. counter	—	—
$S^{34}(n, p) P^{34}$								
16-34b1	P53	12.4 sec	$14.5 \pm 0.35$	$85.2 \pm 38$			cf. 7-14a1	
$S^{34}(n, \alpha) Si^{31}$								
16-34i1	P53	2.7h	$14.5 \pm 0.35$	$138 \pm 35$			cf. 7-14a1	Element
16-34i2	A57 I	$2.5 \pm 0.2 h$	$14.10 \pm 0.04$	$126 \pm 7$	rel. : cf. 16-32b2 $S^{32}(n, p) = 254$ mb		cf. 16-32b2	
$S^{nat}(n, p + n, pn) P$								
16-d1 diff.	H62 III	—	$14.4 \pm 0.2$	$206 \pm 21$ for $E_p > 2.8$ MeV			cf. 12-d1	
$S^{nat}(n, np) P$								
16-e1 diff.	H62 III	—	$14.4 \pm 0.2$	$73 \pm 15$ for $E_p > 2.8$ MeV			cf. 12-d1	
$S^{nat}(n, \alpha) Si$								
16-i1 diff.	K58 III	—	14.8	$38.2 \pm 7.6$	abs. : $\alpha$ from $T(d, n) He^4$	Nuclear plate : Separation of $n, \alpha$ - ; $n, n\alpha$ - ; and $n, \alpha n$ - processes	Estimated total error	$S^{nat}, 2.54$ mg/cm <sup>2</sup>

## C H L O R I N E

### $\text{Cl}^{35}(n, 2n) \text{ Cl}^{34m}$

17-35a1m	P53	33 min	$14.5 \pm 0.35$	$3.47 \pm 1.56$		cf. 7-14a1		
17-35a2m	S59 I	32.4 min	$14.8 \pm 0.8$	$5.6 \pm 2$		cf. 17-24b2		
17-35a3m	R59 I	37.7 min	14	$5.3 \pm 0.4$	rel. : cf. 29-63a $\text{Cu}^{63}(n, 2n) = 500 \text{ mb}$	$\beta^+$ -activity; 0.511 MeV annihilation radiation measured in coincidence with 2 NaI scint. counters	No systematic errors	—
17-35a4m	R61 II	$31.2 \pm 0.6 \text{ min}^*$	$14.4 \pm 0.3$	$5.42 \pm 0.41$		cf. 7-14a7		
17-35a5m	K61 II	33 min	$14.8 \pm 0.5$	$12 \pm 1.8$	rel. : cf. 26-56b $\text{Fe}^{56}(n, p) = 126 \text{ mb}$ Sandwich method	$\beta$ -activity, prop. counter. Corrections for abs. $\beta$ -counting computed	Error contains : neutron flux 2-5 %, statistics 2-8 %, decay const. 1 %, $\gamma$ -pulses 3 %	Powder 20 mg/ $\text{cm}^2\text{m}$ , in tape of 9 mg/ $\text{cm}^2\text{m}$ . Purity 99.9 %

### $\text{Cl}^{35}(n, p) \text{ S}^{35} + \text{Cl}^{35}(n, pn) \text{ S}^{34}$

17-35d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} =$ a) $125 \pm 38$ b) $107 \pm 38$		cf. 11-23d1		
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### $\text{Cl}^{35}(n, \alpha) \text{ P}^{32}$

17-35i1	P53	14d	$14.5 \pm 0.35$	$191 \pm 30$		cf. 7-14a1		
17-35i2	S59 I	14.5d	$14.8 \pm 0.8$	$199 \pm 32$		cf. 17-37b2		

### $\text{Cl}^{37}(n, p) \text{ S}^{37}$

17-37b1	P53	5 min	$14.5 \pm 0.35$	$33.4 \pm 7$		cf. 7-14a1		NH <sub>4</sub> Cl; NaCl; LiCl
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\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
17-37b2	S59 I	5 min	$14.8 \pm 0.8$	$25.4 \pm 2.1$	rel. : cf. 29-63a3 $\text{Cu}^{63}(n, 2n) = 556 \text{ mb}$	$\beta$ -activity, plastic-scintil-lator or prop. counter. Scattering and absorption of the $\beta$ in the target is supposed to be the same as in the Cu-monitor	—	$\text{C}_6\text{Cl}_6$ ; 9.5-12.7 cm o. thickness : $\sim 85 \text{ mg}/\text{cm}^2$
17-37b3	C56			cf. 12-24b8*				
					$\text{Cl}^{37}(n, \alpha) \text{ P}^{34}$			
17-37i1	P53	12.4 sec	$14.5 \pm 0.35$	$52.4 \pm 25$		cf. 7-14a1		
17-37i2	S59I	12.5 sec	$14.8 \pm 0.8$	$43.8 \pm 7$		cf. 17-37b2		

\* Measured for  $12.5 \text{ MeV} \leq E_n \leq 17.5 \text{ MeV}$

## P O T A S S I U M

### $K^{39}(n, 2n) K^{38}$

19-39a1	P53	7.7 min	$14.5 \pm 0.35$	$10 \pm 5.5$	cf. 7-14a1	$KNO_3$
19-39a2	R58 II	7.7 min	14	3.8	cf. 7-14a2	
19-39a3	R61 II	7.7 $\pm$ 0.5 min	$14.4 \pm 0.3$	$3.37 \pm 0.27$	cf. 7-14a7	
19-39a4	K61 II	7.7 min	$14.8 \pm 0.5$	$6 \pm 0.9$	cf. 17-35a5m	

### $K^{39}(n, p) Ar^{39} + K^{39}(n, pn) Ar^{38}$

19-39d1	B60	—	$14.1 \pm 0.1$	$354 \pm 53$	rel.: $KI(n, p) + KI(n, np)$ + $KI(n, \alpha) = 650$ mb and $I(n, p)$ neglected (cf. 53- 127b1)	Total $\sigma$ measured for all charged particles produced in the KI crystal. KI in coincidence with $\alpha$ from $T(d, n) He^4$ . Separation of $\alpha$ -, $p$ -, and $\gamma$ -pulses by pulse - shape - discrimination. Separation of $n, p$ - and $n, np$ - reactions by stat. theory	Stat. error	KI-crystal
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### $K^{39}(n, np) Ar^{38}$

19-39e1	B60	—	$14.1 \pm 0.1$	$186 \pm 27$	cf. 19-39d1
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### $K^{39}(n, \alpha) Cl^{36}$

19-39i1	B60	—	$14.1 \pm 0.1$	$84 \pm 13$	cf. 19-39d1	Instead of $n, p$ -; $n, np$ say $n, \alpha$ -; $n, n\alpha$
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### $K^{41}(n, p) Ar^{41}$

19-41b1	P53	110 min	$14.5 \pm 0.35$	$81.2 \pm 32.5$	cf. 7-14a1	$KNO_3$
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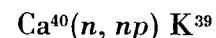
I	II	III	IV	V	VI	VII	VIII	IX
$\text{K}^{41}(n, \text{He}^3) \text{ Cl}^{39}$								
19-41 <i>f</i> 1	B62 II	55.5 min	14.7	< 2.5	—	—	—	—
$\text{K}^{41}(n, 2p) \text{ Cl}^{40}$								
19-41 <i>h</i> 1	B62 II	1.4 min	14.7	< 0.090	—	—	—	—
$\text{K}^{41}(n, \alpha) \text{ Cl}^{38}$								
19-41 <i>i</i> 1	P53	38 min	$14.5 \pm 0.35$	$31.4 \pm 11$	cf. 7-14 <i>a</i> 1		$\text{KNO}_3$	
19-41 <i>i</i> 2	B60	38 min	$14.1 \pm 0.1$	$12 \pm 13$	rel. : cf. 53-127 <i>a</i> $\text{I}^{127}(n, 2n) = 1200 \text{ mb}$	$\beta$ -activity, KI-crystal served as target and 4 $\pi$ counter	Stat. error	KI crystal

I	II	III	IV	V	VI	VII	VIII	IX
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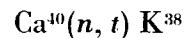
## C A L C I U M



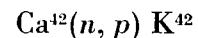
20-40d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) $451 \pm 38$ b) $298 \pm 38$	cf. 11-23d1
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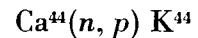
20-40e1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ 205 $\pm$ 37	cf. 11-23d1
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20-40h1	W62	—	$14.7 \pm 0.3$	$< 0.1$	cf. 29-63a11
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20-42b1	H62 I	$12.37 \pm 0.09 h^*$	14.9	$140 \pm 45$ rel.: cf. 13-27i10 $\text{Al}^{27}(n, \alpha) = 116 \text{ mb}$	$\gamma$ -activity, measuring of the area under the photo-peak with a $1 \times 1\frac{1}{2}''$ NaI crystal	Mean total error	$\text{CaCO}_3$
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20-44b2	H62 I	$22 \pm 0.3 \text{ min}^*$	14.9	$25 \pm 12$	cf. 20-42b1
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\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Ca}^{44}(n, \alpha) \text{ Ar}^{41}$								
20-44 <i>i</i> 1	H62 I	1.85 <i>h</i>	14.9	35 $\pm$ 10			cf. 20-42 <i>b</i> 1	
$\text{Ca}^{48}(n, 2n) \text{ Ca}^{47}$								
20-48 <i>a</i> 1	H62 I	—	14.9	1070 $\pm$ 360			cf. 20-42 <i>b</i> 1	

## S C A N D I U M

$\text{Sc}^{45}(n, 2n) \text{ Sc}^{44g}$

21-45a1g	P61 I	$3.92h$	$14.01 \pm 0.10$	$138.5 \pm 5.2^{*1}$		cf. 22-46a2
			$14.09 \pm 0.10$	$150.0 \pm 5.7$		
			$14.31 \pm 0.13$	$169.0 \pm 6.4$		
			$14.50 \pm 0.20$	$181.4 \pm 6.9$		
			$14.68 \pm 0.26$	$204.3 \pm 7.7$		
21-45a2g	M61 II	—	14.8	$179 \pm 27$		cf. 11-23i2
21-45a3g	R61 II	$4.04 \pm 0.08^{*2}$	$14.4 \pm 0.3$	$198 \pm 15$		cf. 7-14a7
21-45a4g	K59 II	$4.01h$	$14.3 \pm 0.5$	$129 \pm 9$		cf. 13-27b7
21-45a5g	K61 II	$4.01h$	$14.8 \pm 0.5$	$148 \pm 22$		cf. 17-35a5m

$\text{Sc}^{45}(n, 2n) \text{ Sc}^{44m}$

21-45a1m	P61 I	$2.44h$	$14.01 \pm 0.10$	$107.4 \pm 3.5^{*1}$		cf. 22-46a2
			$14.09 \pm 0.10$	$116.2 \pm 3.7$		
			$14.31 \pm 0.13$	$127.3 \pm 4.1$		
			$14.50 \pm 0.20$	$134.3 \pm 4.3$		
			$14.68 \pm 0.26$	$144.7 \pm 4.6$		
21-45a2m	M61 II	—	14.8	$149 \pm 22$		cf. 11-23i2
21-45a3m	R61 II	$59.1 \pm 1.2h^{*2}$	$14.4 \pm 0.3$	$149 \pm 11$		cf. 7-14a7

$\text{Sc}^{45}(n, 2n) \text{ Sc}^{44tot}$

21-45a1t	P61 I	—	$14.01 \pm 0.10$	$249.5 \pm 6.2^{*1}$		cf. 22-46a2
			$14.09 \pm 0.10$	$266.2 \pm 6.7$		
			$14.31 \pm 0.13$	$296.3 \pm 7.7$		
			$14.50 \pm 0.20$	$315.7 \pm 8.2$		
			$14.68 \pm 0.26$	$349.0 \pm 9.1$		

\*1 Also measured for  $11.6 \text{ MeV} \leq E_n \leq 19.6 \text{ MeV}$

\*2 Measured by the authors

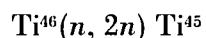
I	II	III	IV	V	VI	VII	VIII	IX
$\text{Sc}^{45}(n, p) \text{ Ca}^{45}$								
21-45b1	P61 I	—	14.09 $\pm$ 0.10 14.31 $\pm$ 0.13 14.54 $\pm$ 0.20 14.81 $\pm$ 0.31	54 $\pm$ 4* <sup>1</sup> 55.5 $\pm$ 4 57 $\pm$ 4 49.5 $\pm$ 4		cf. 22-46a2		
21-45f1	B62 II	22h		14.7	< 0.30			
21-45h1	B62 II	22 min		14.7	< 0.21	—	—	—
$\text{Sc}^{45}(n, \text{He}^3) \text{ K}^{43}$								
21-45i1	K59 II	12.4h		14.3 $\pm$ 0.5	132 $\pm$ 8		cf. 13-27b7	
21-45i2	M61 II	—		14.8	63 $\pm$ 9.5		cf. 11-23i2	
21-45i3	P61 I			14.09 $\pm$ 0.10* <sup>2</sup> 14.31 $\pm$ 0.13 14.50 $\pm$ 0.20 14.81 $\pm$ 0.31	55 $\pm$ 2.7 55 $\pm$ 2.7 56.3 $\pm$ 2.8 53.5 $\pm$ 2.7		cf. 22-46a2	

\*<sup>1</sup> Also measured for 13.4 MeV  $\leq E_n \leq$  14.8 MeV

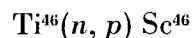
\*<sup>2</sup> Also measured for 8 MeV  $\leq E_n \leq$  19.6 MeV

I	II	III	IV	V	VI	VII	VIII	IX
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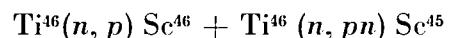
## TITANIUM



22-46a1	R58 II	$2.9h$	14	27.9		cf. 7-14a2		
22-46a2	P61 I	3.09	$13.88 \pm 0.10^{*1}$	$7.0 \pm 1$	rel. : cf. 13-27i9	$\beta$ -activity, $2\pi$ geometry. Corrections for absolute $\beta$ -counting exp. determined (cf. B59 I). Measuring of the activity after chem. separation	—	—
			$14.09 \pm 0.10$	$13 \pm 3$				
			$14.50 \pm 0.20$	$28.0 \pm 3$				
			$14.93 \pm 0.36$	$44.5 \pm 3$				
22-46a3	P59 I	$3.06 \pm 0.08h^{*2}$	$14.8 \pm 0.8$	$50.4 \pm 8.1$		cf. 13-27b4		Element, discs, 1.7- 2.1 cm $\otimes$ thickness 3 mg/cm <sup>2</sup>
22-46a4	R61 II	$2.91 \pm 0.06h^{*2}$	$14.4 \pm 0.3$	$31.8 \pm 2.4$		cf. 7-14a7		



22-46b1	P59 I	$85 \pm 2d^{*2}$	$14.8 \pm 0.8$	$\sim 520$		cf. 13-27b4		Element, nat., discs 1.7-2.1 cm $\otimes$ 8 mg/ cm <sup>2</sup> thickness. $\text{TiO}_2$ powder enriched : $\text{Ti}^{47}(86.6\%)$ , $\text{Ti}^{49}$ (81.1%), $\text{Ti}^{50}(84.69\%)$
22-46b2	R62	—	—	$\sim 240$	—	—	—	—



22-46d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) $203 \pm 20$ b) $196 \pm 20$		cf. 11-23d1	
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\*1 Also measured for  $13.4 \text{ MeV} \leq E_n \leq 19.5 \text{ MeV}$

\*2 Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Ti}^{47}(n, p) \text{ Sc}^{47}$								
22-47b1	P59 I	$3.45 \pm 0.06d^{*1}$	$14.8 \pm 0.8$	$230 \pm 39$		cf. 13-27b4		cf. 22-46b1
22-47b2	R62	—	—	170	—	—	—	—
$\text{Ti}^{47}(n, p) \text{ Sc}^{47} + \text{Ti}^{47}(n, pn) \text{ Sc}^{46}$								
22-47d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} =$ a) $112 \pm 16$ b) $111 \pm 16$		cf. 11-23d1		
$\text{Ti}^{48}(n, p) \text{ Sc}^{48}$								
22-48b1	P53	$1.8d$	$14.5 \pm 0.35$	$92.7 \pm 32.4$		cf. 7-14a1		TiHx
22-48b2	P59 I	$14.0 \pm 0.9h^{*1}$	$14.8 \pm 0.8$	$58 \pm 6.7$		cf. 13-27b4		cf. 22-46b1
22-48b3	G61IV	—	$13.9^{*2}$ $14.4 \pm 0.15$ 15	$66 \pm 2$ $66 \pm 3$ $65 \pm 3$		cf. 12-24b10		
$\text{Ti}^{48}(n, p) \text{ Sc}^{48} + \text{Ti}^{48}(n, pn) \text{ Sc}^{47}$								
22-48d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} =$ a) $29 \pm 8$ b) $29 \pm 8$		cf. 11-23d1		
$\text{Ti}^{49}(n, p) \text{ Sc}^{49}$								
22-49b1	P59 I	$58 \pm 2 \text{ min}^{*1}$	$14.8 \pm 0.8$	$29 \pm 5$		cf. 13-27b4		cf. 22-46b1
22-49b2	K59 II	56.3 min	$14.3 \pm 0.5$	$97 \pm 17$		cf. 13-27b7		

\*1 Measured by the authors

\*2 Also measured for  $12.7 \leq E_n \leq 17 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Ti}^{50}(n, p) \text{ Sc}^{50}$ I								
22-50b1 I	P59 I	$1.80 \pm 0.20$ min*	$14.8 \pm 0.8$	$27 \pm 6$		cf. 13-27b4		cf. 22-46b1
22-50b2 I	K59 II	1.55 min	$14.3 \pm 0.5$	$147 \pm 13$		cf. 13-27b7		
$\text{Ti}^{50}(n, p) \text{ Sc}^{50}$ II								
22-50b1 II	P59 I	$22 \pm 0.3$ min*	$14.8 \pm 0.8$	$48 \pm 15$		cf. 13-27b4		cf. 22-46b1
$\text{Ti}^{50}(n, 2p) \text{ Ca}^{49}$								
22-50h1	B62 II	8.8 min	14.7	$< 0.10$	—	—	—	—
$\text{Ti}^{nat}(n, p + n, pn) \text{ Sc}$								
22-d1 diff.	H62 III	—	$14.4 \pm 0.2$	$35 \pm 4$ for $E_p > 3.7$ MeV		cf. 12-d1		

\* Measured by the authors



## V A N A D I U M

$$V^{51}(n, 2n) V^{50}$$

23-51a1	A58 I		—	14.1	$660 \pm 50$		cf. 1-2a1	Element
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$$V^{51}(n, p) Ti^{51}$$

23-51b1	P53	6 min	$14.5 \pm 0.35$	$27 \pm 4$		—	cf. 7-14a1	$V_2O$
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23-51b2	P61 IV		—	14.8	$53 \pm 5$	—	—	—
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$$V^{51}(n, p) Ti^{51} + V^{51}(n, pn) Ti^{50}$$

23-51d1 diff.	A61		—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} =$ a) $20 \pm 7.0$ b) $23 \pm 7.0$		cf. 11-23d1	
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$$V^{51}(n, He^3) Sc^{49}$$

23-51f1	B62 II	57 min	14.7	$< 0.33$	—	—	—	—
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$$V^{51}(n, 2p) Sc^{50}$$

23-51h1	B62 II	1.7 min	14.7	$< 0.30$	—	—	—	—
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$$V^{51}(n, \alpha) Sc^{48}$$

23-51i1	P53	1.8d	$14.5 \pm 0.35$	$28.6 \pm 7.8$		cf. 7-14a1	
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23-51i2	K58 III		—	14.8	$43.2 \pm 8.5$		cf. 16-i1	Element,
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23-51i3	B61 III	44h	$14.4 \pm 0.3$	$43 \pm 3$		cf. 29-65a8	2.54 mg/cm <sup>2</sup>
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I	II	III	IV	V	VI	VII	VIII	IX
				$\text{V}^{51}(n, n\alpha) \text{ Sc}^{47}$				
23-51k1	B62 I	81-4 <i>h</i>	14.1 $\pm$ 0.1* <sup>1</sup>	3 $\pm$ 2	rel. : cf. 13-27 <i>i</i> $\text{Al}^{27}(n, \alpha) = 118 \text{ mb}$	cf. 29-65 <i>a</i> 8		$\text{V}_2\text{O}_3$ powder
23-51k2	B62 II	3.4 <i>d</i>	14.7	< 5	—	—	—	—

\*<sup>1</sup> Also measured from threshold to 19.6 MeV

## C H R O M I U M

### $\text{Cr}^{50}(n, 2n) \text{ Cr}^{49}$

24-50a1	R58 II	38.5 min	14	25.4		cf. 7-14a2		
24-50a2	M61 II	—	14.8	$32 \pm 3$		cf. 11-23i2		
24-50a3	R61 II	$38.5 \pm 1.5$ min*	$14.4 \pm 0.3$	$26.4 \pm 2.2$		cf. 7-14a7		Element
24-50a4	K61 II	41.6 min	$14.8 \pm 0.5$	$27 \pm 6.8$		cf. 17-35a5m		

### $\text{Cr}^{50}(n, p) \text{ V}^{50} + \text{Cr}^{50}(n, pn) \text{ V}^{49}$

24-50d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) $265 \pm 21$ b) $277 \pm 20$		cf. 11-23d1		
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### $\text{Cr}^{50}(n, np) \text{ V}^{49}$

24-50e1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ $153 \pm 21$		cf. 11-23d1		
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### $\text{Cr}^{52}(n, 2n) \text{ Cr}^{51}$

24-52a1	W61 I	—	15.0	$280 \pm 50$	rel. : cf. 13-27i10 $\text{Al}^{27}(n, \alpha) = 116 \text{ mb}$	$\gamma$ -activity. Measuring of the area under the photo-peak and K-electron capture	Total error	—
24-52a2	H62 I	—	14.9	$280 \pm 50$		cf. 20-48a1		

### $\text{Cr}^{52}(n, p) \text{ V}^{52}$

24-52b1	P53	3.9 min	$14.5 \pm 0.35$	$77.7 \pm 11$		cf. 7-14a1		
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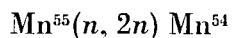
\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
24-52b2	K59 III	—	$14.0 \pm 0.4^*$ $14.2 \pm 0.4$ $14.5 \pm 0.4$ $14.7 \pm 0.4$ $15.0 \pm 0.4$ $15.0 \pm 0.4$	$133 \pm 15$ $109 \pm 13$ $106 \pm 10$ $113 \pm 12$ $114 \pm 11$ $101 \pm 10$		cf. 13-27 <i>i</i> 7		
24-52b3	M61 II	—	14.8	$105 \pm 10$		cf. 11-23 <i>i</i> 2		
24-52b4	F58 II	—	—	$\sim 103$	—	—	—	—
24-52b5	C61 II	—	—	$83 \pm 10$	—	—	—	—
$\text{Cr}^{52}(n, p) \text{ V}^{52} + \text{Cr}^{52}(n, pn) \text{ V}^{51}$								
24-52d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} =$ a) $74 \pm 10$ b) $67 \pm 10$		cf. 11-23 <i>d</i> 1		
$\text{Cr}^{53}(n, p) \text{ V}^{53}$								
24-53b1	C61 II	—	14.8	$37 \pm 4$	—	—	—	—
$\text{Cr}^{53}(n, p) \text{ V}^{53} + \text{Cr}^{53}(n, pn) \text{ V}^{52}$								
24-53d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} =$ a) $44 \pm 6.6$ b) $48 \pm 7.2$		cf. 11-23 <i>d</i> 1		

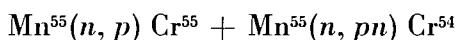
\* Also measured for  $12.33 \text{ MeV} \leq E_n \leq 18.24 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
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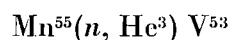
## M A N G A N E S E



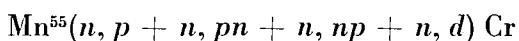
25-55a1	W61 I	—	14.1	$600 \pm 120$		cf. 24-51a1		
25-55a2	W60 II	291d	$14.5 \pm 0.5$	$825 \pm 190$		cf. 29-65a10		
25-55a3	H62 I	—	14.1	$600 \pm 120$		cf. 20-48a1		



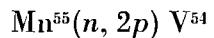
25-55d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} =$ a) $43 \pm 7$ b) $45 \pm 7$		cf. 11-23d1		
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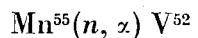
25-55f1	B62 II	1.7 min	14.7	$< 0.42$	—	—	—	—
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25-55g1	A58 III	—	14	$110 \pm 15$	rel. : cf. 28-b, d $\text{Ni}nat(n, p) = 440 \text{ mb}$	Nuclear plate	—	12 mg/cm <sup>2</sup> thickness
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25-55h1	B62 II	55 sec	14.7	$< 0.36$	—	—	—	—
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25-55i1	P53	3.9 min	$14.5 \pm 0.35$	$52.5 \pm 7.9$	cf. 7-14a1		$\text{MnO}_2$
25-55i2	K58 III	—	14.8	$39.4 \pm 8$	cf. 16-i1		3.3 mg/cm <sup>2</sup> thickness

I	II	III	IV	V	VI	VII	VIII	IX
25-55 <i>i</i> 3	G61 IV	—	$14.3 \pm 0.1^*$ $14.7 \pm 0.2$ $14.9 \pm 0.2$	$31 \pm 2$ $33 \pm 3$ $34 \pm 2$	—	—	—	—
25-55 <i>i</i> 4	F61 I	—	14.8	$11.8 \pm 0.7$	—	—	—	—

\* Also measured for  $12.4 \text{ MeV} \leq E_n \leq 17.7 \text{ MeV}$

## IRON

Fe<sup>54</sup>(n, 2n) Fe<sup>53</sup>

26-54a1	R58 II	9.8 min	14	16.7	cf. 7-14a2	
26-54a2	P61 III	8.3 ± 0.5 min*	14.1 ± 0.1	11 ± 2	cf. 13-27b8	Element
26-54a3	C61 I	8.4 ± 0.4 min*	14.8 ± 0.9	7.9 ± 0.8	cf. 27-59a1g	Fe <sub>2</sub> <sup>54</sup> O <sub>3</sub> enriched (99.6 %) thickness 10-55 mg/ cm <sup>2</sup>
26-54a4	D60 II	—	15 ± 0.4	~7	cf. 26-56b11	thickness ~27 mg/ cm <sup>2</sup>
26-54a5	R61 II	8.80 ± 0.24 min*	14.4 ± 0.3	15.0 ± 1.3	cf. 7-14a7	Element

Fe<sup>54</sup>(n, p) Mn<sup>54</sup>

26-54b1	P61 III	260 ± 15d*	14.1 ± 0.1	254 ± 28	cf. 13-27b8	Element
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Fe<sup>54</sup>(n, p) Mn<sup>54</sup> + Fe<sup>54</sup>(n, pn) Mn<sup>53</sup>

26-54d1	A57 II	—	14.1	460 ± 92	cf. 13-27d1	Fe <sup>54</sup> enriched, thick- ness 5-12 mg/cm <sup>2</sup>
26-54d2 diff.	A59	—	14.1	a) $4 \frac{d\sigma}{d\Omega} = 395$ for $d\Omega = 90^\circ - 180^\circ$ b) $2 \frac{d\sigma}{d\Omega} = 415$ for $d\Omega = 0^\circ - 180^\circ$	abs. : α-from T(d, n) He <sup>4</sup> Shielded nuclear plate surrounded by several targets arranged on a cir- cle. Separation of n,p- and n,np-processes by stat. theory	—
26-54d3 diff.	A61 I	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} =$ a) $382 \pm 13$ b) $382 \pm 13$	cf. 11-23d1	Fe <sup>54</sup> enriched : —88.4 % ; thickness 27 mg/cm <sup>2</sup>

\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
26-54d4 diff.	S60	—	14.1	$2 \frac{d\sigma}{d\Omega} = 333 \pm 66$ for $d\Omega = 0^\circ - 180^\circ$		cf. 13-27d3		
26-54d5 diff.	M58 1	—	$13.5 \pm 0.1$	306 for isotr. part 376 for total	abs. : recoil protons in a nuclear plate	Nuclear plate. Separation of $n, p$ - and $n, np$ -processes by stat. theory. $\sigma$ probably contains $n, d$ -processes	—	Fe <sup>54</sup> enriched : 67 %, thickness 7 mg/cm <sup>2</sup>
<b>Fe<sup>54</sup>(<math>n, np</math>) Mn<sup>53</sup></b>								
26-54e1	A57 II	—	14.1	$220 \pm 44$		cf. 13-27d1		
26-54e2 diff.	A61		14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ $218 \pm 13$		cf. 11-23d1		
26-54e3 diff.	M58 11	—	$13.5 \pm 0.1$	224		cf. 26-54d5		
<b>Fe<sup>54</sup>(<math>n, t</math>) Mn<sup>52m</sup></b>								
26-54h1m	C61 I	$21 \pm 2$ min*	$14.8 \pm 0.9$	$0.6 \pm 0.1$		cf. 27-59a1g		cf. 26-54a3
<b>Fe<sup>54</sup>(<math>n, \alpha</math>) Cr<sup>51</sup></b>								
26-54i1	P61 III	$25 \pm 2d^*$	$14.1 \pm 0.1$	$131 \pm 24$		cf. 13-27b8		
26-54i2	C61 1	$25 \pm 5d^*$	$14.8 \pm 0.9$	$270 \pm 135$		cf. 27-59a1g		cf. 26-54a3
<b>Fe<sup>56</sup>(<math>n, 2n</math>) Fe<sup>55</sup></b>								
26-56a1	H62 I	—	14.9	$440 \pm 88$		cf. 20-48a1		

\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
<b>Fe<sup>56</sup>(n, p) Mn<sup>56</sup></b>								
26-56b1	P53	2.6 <i>h</i>	14.5 ± 0.35	96.7 ± 11.6		cf. 7-14 <i>a</i> 1		Element
26-56b2	F52	2.59 <i>h</i>	14.1	124 ± 12		cf. 13-27 <i>b</i> 2		
26-56b3	Y57	2.57 <i>h</i>	14.1 ± 0.15	144 ± 19		cf. 26-56b3		
26-56b4	P61 III	2.58 ± 0.03 <i>h</i> * <sup>1</sup>	14.1 ± 0.1	112.5 ± 5.6		cf. 13-27 <i>b</i> 8		
26-56b5	C61 I	2.56 ± 0.11 <i>h</i> * <sup>1</sup>	14.8 ± 0.9	128 ± 13		cf. 27-29 <i>a</i> 1g		Element-nat. Fe <sub>2</sub> O <sub>3</sub> enriched : Fe <sup>58</sup> (78.4 %); Fe <sup>57</sup> (76.7 %) thickness 10-25 mg/ cm <sup>2</sup>
26-56b6	C55	—	14	72 ± 7	—	Activation	—	—
26-56b7	D60 II	—	15 ± 0.4	128 ± 13	rel. : cf. 29-63 <i>a</i> 3 Cu <sup>63</sup> (n, 2n) = 556 mb Sandwich-method	β-activity, prop. counter, nearly 2π geometry	—	Foils of 1.8 cm <sup>2</sup> , thickness 27 mg/cm <sup>2</sup>
26-56b8	K59 III	—	15.27 ± 0.33	131 ± 15		cf. 13-27 <i>i</i> 7		
26-56b9	T58	Rel. measurement. Experimental* <sup>2</sup> curve was fitted by $\sigma = 110 \pm 10$ mb for E <sub>n</sub> = 14.3 MeV				β-activity, geiger counter	—	Fe nat 10" long 1/2" Ø
26-56b10	B62 I	Rel. measurement. Experimental curve* <sup>3</sup> was fitted by $\sigma = 112.5$ mb for E <sub>n</sub> = 14.1 MeV cf. 26-56b4				cf. 13-27 <i>b</i> 8		

**Fe<sup>56</sup>(n, p) Mn<sup>56</sup> + Fe<sup>56</sup>(n, pn) Mn<sup>55</sup>**

26-56d1	A57 II	—	14.1	190 ± 38	cf. 13-27 <i>d</i> 1
26-56d2 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) 82 ± 7.3 b) 86 ± 7	cf. 11-23 <i>d</i> 1

\*<sup>1</sup> Measured by the authors

\*<sup>2</sup> Measured for 3.4 MeV ≤ E<sub>n</sub> ≤ 8.2 MeV and 12.4 MeV ≤ E<sub>n</sub> ≤ 17.9 MeV

\*<sup>3</sup> Measured for 13 MeV ≤ E<sub>n</sub> ≤ 19 MeV

I	II	III	IV	V	VI	VII	VIII	IX
26-56d3 diff.	S60	—	14.1	$2 \cdot \frac{d\sigma}{d\Omega} = 90 \pm 18$ for $d\Omega = 0^\circ - 180^\circ$		cf. 13-27d3		
26-56d4 diff.	A58 I	—	$13.5 \pm 0.1$	75 for isotr. part 95 for total		cf. 26-54d5		Fe <sup>56</sup> enriched : 99.9 %, thickness 4.5 mg/cm <sup>2</sup>
$\text{Fe}^{56}(n, np) \text{ Mn}^{55}$								
26-56e1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ 35 ± 7		cf. 11-23d1		
$\text{Fe}^{57}(n, p) \text{ Mn}^{57}$								
26-57b1	P61 III	$1.4 \pm 0.2$ min*	$14.1 \pm 0.1$	$50 \pm 8$		cf. 13-27b8		
26-57b2	C61 I	$1.5 \pm 0.1$ min*	$14.8 \pm 0.9$	$71 \pm 7$		cf. 27-59a1g		cf. 26-56b5
$\text{Fe}^{57}(n, pn + n, np + n, d) \text{ Mn}^{56}$								
26-57c1	C61 I	$2.56 \pm 0.20h^*$	$14.8 \pm 0.9$	$6.1 \pm 2.6$		cf. 27-59a1g		cf. 26-56b5
$\text{Fe}^{58}(n, p) \text{ Mn}^{58}$								
26-58b1	C61 I	$1.1 \pm 0.1$ min*	$14.8 \pm 0.9$	$23 \pm 3.5$		cf. 27-59a1g		cf. 26-56b5
$\text{Fe}^{58}(n, \alpha) \text{ Cr}^{55}$								
26-58c1	C61 I	$3.5 \pm 0.1$ min*	$14.8 \pm 0.9$	$21.5 \pm 2$		cf. 27-59a1g		cf. 26-56b5
$\text{Fe}^{nat}(n, 2n)$								
26-a1	A58 II	—	14.1	$500 \pm 40$		cf. 1-2a1		

\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
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$\text{Fe}^{nat}(n, p + n, pn)$								
26- <i>dI</i> diff.	H62 III	—	$14.4 \pm 0.2$	$102 \pm 10$ for $E_p > 2.8 \text{ MeV}$		cf. 12- <i>dI</i>		
26- <i>gI</i> diff.	V57	—	14.5	$4\pi \left[ \frac{d\sigma}{d\theta} \right] = 90 \pm 15$ means for $0 = 30^\circ$ , $45^\circ, 60^\circ, 90^\circ, 120^\circ,$ $135^\circ, 150^\circ$ , and $E_p >$ 6 MeV		cf. 12- <i>gI</i>		
$\text{Fe}^{nat}(n, p + n, pn + n, np + nd)$								



## C O B A L T

### $\text{Co}^{59}(n, 2n) \text{ Co}^{58}$ - tot.

27-59a <sub>1</sub> t	W60 II	—	$14.5 \pm 0.5$	$855 \pm 190$		cf. 29-65a10		
27-59a <sub>2</sub> t	B61 III	$70 \pm 2d^{*1}$ for $\text{Co}^{58g}$	$14.4 \pm 0.3^{*2}$	$640 \pm 64$		cf. 29-65a8	CoO	
27-59a <sub>3</sub> t	H61 I	—	14.1	$630 \pm 126$		cf. 20-48a1		
27-59a <sub>4</sub> t	G61 IV	—	$14.25 \pm 0.05^{*3}$	$870 \pm 130$	—	—	—	—
			$14.5 \pm 0.1$	$930 \pm 100$				
			$14.75 \pm 0.1$	$1020 \pm 120$				
			$15 \pm 0.15$	$970 \pm 100$				
27-59a <sub>5</sub> t	W62	$71.4d$ for $\text{Co}^{58g}$	$13.86 \pm 0.10$	$727 \pm 58$		cf. 29-63a11		
			$14.11 \pm 0.10$	$776 \pm 62$				
			$14.37 \pm 0.15$	$767 \pm 61$				
			$14.59 \pm 0.20$	$823 \pm 66$				
			$14.77 \pm 0.25$	$827 \pm 66$				

### $\text{Co}^{59}(n, 2n) \text{ Co}^{58g}$

27-59a <sub>1</sub> g	P60 I	72d	$14.8 \pm 0.9$	$145 \pm 5$	rel. : cf. 29-65a $\text{Cu}^{65}(n, 2n) = 1000$ mb ; cf. 13-27i : $\text{Al}^{27}(n, \alpha) =$ $115$ mb ; cf. 29-63a3 : $\text{Cu}^{63}(n, 2n) = 556$ mb Sandwich method	$\beta$ - and $\gamma$ -activity a) $\beta$ -activity : cf. 13-27b4 b) $\gamma$ -activity : $1 \times 1.5''$ NaI crystal. Corrections for abs. $\gamma$ -counting cf. B55 I Chemical separation	cf. 13-27b4	Element, discs, thick- ness : 3-35 mg/cm <sup>2</sup>
27-59a <sub>2</sub> g	W60 II	71d	$14.5 \pm 0.5$	$473 \pm 120$		cf. 29-65a1		

\*<sup>1</sup> Measured by the authors

\*<sup>2</sup> Also measured for  $12.6 \text{ MeV} \leq E_n \leq 19.6 \text{ MeV}$

\*<sup>3</sup> Also measured for  $12.6 \text{ MeV} \leq E_n \leq 17.1 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Co}^{59}(n, 2n) \text{ Co}^{58m}$								
27-59a1m	P60 I	9.0 $\pm$ 0.2 <sup>*1</sup>	14.8 $\pm$ 0.9	4 $\pm$ 2			cf. 27-59a1g	
27-59a2m	B62 I	9h	14.5 $\pm$ 0.5 <sup>*2</sup>	385 $\pm$ 100			cf. 29-65a8	
$\text{Co}^{59}(n, p) \text{ Fe}^{59}$								
27-59b1	P60 I	45d	14.8 $\pm$ 0.9	82 $\pm$ 8			cf. 27-59a1g	
27-59b2	W60 II	—	14.5 $\pm$ 0.5	80 $\pm$ 23			cf. 29-65a10	
$\text{Co}^{59}(n, p) \text{ Fe}^{59} + \text{Co}^{59}(n, pn) \text{ Fe}^{58}$								
27-59d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) 81 $\pm$ 10 b) 61 $\pm$ 10			cf. 11-23d1	
27-59d2 diff.	S60	—	14.1	$2 \cdot \frac{d\sigma}{d\Omega} = 75 \pm 15$ for $d\Omega = 0^\circ - 180^\circ$			cf. 13-27d3	
27-59d3 diff.	H62 III	—	14.4 $\pm$ 0.2	48 $\pm$ 5 for $E_p > 3 \text{ MeV}$			cf. 12-d1	
$\text{Co}^{59}(n, np) \text{ Fe}^{58}$								
27-59e1 diff.	H62 III	—	14.4 $\pm$ 0.2	$\sim 11$ for $E_p > 3 \text{ MeV}$			cf. 12-d1	
$\text{Co}^{59}(n, \text{He}^3) \text{ Mn}^{57}$								
27-59f1	B62 II	1.7 min	14.7	< 0.10	—	—	—	—

<sup>\*1</sup> Measured by the authors

<sup>\*2</sup> Also measured for  $12.6 \text{ MeV} \leq E_n \leq 19.6 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Co}^{59}(n, \alpha) \text{Mn}^{56}$								
27-59 <i>i</i> 1	P53	2.6 <i>h</i>	14.5 $\pm$ 0.35	39.1 $\pm$ 7.5		cf. 7-14 <i>a</i> 1		
27-59 <i>i</i> 2	P60 I	2.57 $\pm$ 0.02 <i>h</i> <sup>*1</sup>	14.8 $\pm$ 0.9	30 $\pm$ 3		cf. 27-59 <i>a</i> 1g		
27-59 <i>i</i> 3	B58	2.59 <i>h</i>	14.05 $\pm$ 0.55	31 $\pm$ 3	rel. : cf. 26-56 <i>b</i> $\text{Fe}^{56}(n, p) = 110 \text{ mb}$ Sandwich-method	$\beta$ -activity, prop.-counter. Corrections for abs. $\beta$ -counting : cf. N52, J50. Chemical separation	Estimated total error	Powder 3/4'' $\times$ 1 1/2'' thickness : 3/4-1 mg/ cm <sup>2</sup>
27-59 <i>i</i> 4	K58 III	—	14.8	25 $\pm$ 5		cf. 16- <i>i</i> 1		
27-59 <i>i</i> 5	W60 II	2.58 <i>h</i>	14.5 $\pm$ 0.5	29 $\pm$ 6		cf. 29-65 <i>a</i> 10		
27-59 <i>i</i> 6	G61 IV	—	14.3 <sup>*2</sup> 15.0	36 $\pm$ 4 30 $\pm$ 4	—	—	—	—
27-59 <i>i</i> 7	B61 III	2.57 <i>h</i>	14.4 $\pm$ 0.3 <sup>*3</sup>	29 $\pm$ 3		cf. 29-65 <i>a</i> 8		

<sup>\*1</sup> Measured by the authors

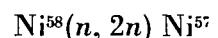
<sup>\*2</sup> Also measured for 12.6 MeV  $\leq E_n \leq$  17.1 MeV

<sup>\*3</sup> Also measured for 12.6 MeV  $\leq E_n \leq$  19.6 MeV



I	II	III	IV	V	VI	VII	VIII	IX
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## N I C K E L



28-58a1	P53	<i>36h</i>	$14.5 \pm 0.35$	$40.6 \pm 12$		cf. 7-14a1		
28-58a2	P61 I	$37 \pm 1h^{*1}$	$14.8 \pm 0.8$	$52 \pm 2.6$		cf. 27-59a1g		Element, $\text{Ni}^{58}$ enriched: 99.63%; thickness : 3-5 mg/cm <sup>2</sup>
28-58a3	R59 I	<i>44h</i>	14	$33.4 \pm 2.7$		cf. 17-35a3m		
28-58a4	P59 II	<i>36h</i>	14.1	$38.8 \pm 8.2$	rel. : cf. 29-65a $\text{Cu}^{65}(n, 2n) = ?$	$\beta^+$ activity; 0.511 MeV annihilation radiation measured in coinc. with 2 scintillation-counters. Calibration with Na <sup>22</sup>	Neutron-flux : 7 %, calibration : 12 %	Element, nat.
28-58a5	P61 I	<i>36h</i>	$13.88 \pm 0.10^{*2}$ $14.09 \pm 0.10$ $14.31 \pm 0.13$ $14.50 \pm 0.20$ $14.81 \pm 0.31$	$21.4 \pm 1.1$ $23.5 \pm 1.3$ $31.1 \pm 1.6$ $34.3 \pm 1.7$ $39.3 \pm 2.0$		cf. 22-46a2		
28-58a6	R61 II	$43.7 \pm 0.9h^{*1}$	$14.4 \pm 0.3$	$34.2 \pm 2.6$		cf. 7-14a7		
28-58a7	G62	<i>37h</i>	$13.86 \pm 0.10$ $14.11 \pm 0.10$ $14.24 \pm 0.10$ $14.37 \pm 0.15$ $14.49 \pm 0.20$ $14.59 \pm 0.20$ $14.69 \pm 0.25$ $14.77 \pm 0.25$ $14.88 \pm 0.30$	$18.7 \pm 1.5$ $22.9 \pm 1.8$ $27.2 \pm 2.2$ $29.3 \pm 2.3$ $31.7 \pm 2.5$ $33.5 \pm 2.7$ $35.9 \pm 2.9$ $36.2 \pm 2.9$ $39.5 \pm 3.2$		cf. 29-63a11		

\*1 Measured by the authors

\*2 Also measured from 12.2 MeV  $\leq E_n \leq$  19.8 MeV

I	II	III	IV	V	VI	VII	VIII	IX
28-58a8	M52		Only relative measurement* <sup>1</sup>		$\beta$ -activity : geiger-counter		—	—
28-58b1	P59 II	—	14.1	$560 \pm 110$		cf. 28-58a4		
					$\text{Ni}^{58}(n, p) \text{ Co}^{58}$			
28-58b1g	P60 I	72d	$14.8 \pm 0.9$	$237 \pm 20$		cf. 27-59a1g		
						NiO powder enriched : Ni <sup>61</sup> (83.1 %); Ni <sup>62</sup> (97.8 %); Ni <sup>64</sup> (95.9 %)		
						Element, powder enriched : Ni <sup>60</sup> (99.1 %)		
						Element, foils enriched : Ni <sup>58</sup> (99.6 %)		
28-58b2g	G62	71.4d	$13.86 \pm 0.10$ $14.11 \pm 0.10$ $14.24 \pm 0.10$ $14.37 \pm 0.15$ $14.49 \pm 0.20$ $14.59 \pm 0.20$ $14.69 \pm 0.25$ $14.77 \pm 0.25$ $14.88 \pm 0.30$	$436 \pm 35$ $435 \pm 35$ $437 \pm 35$ $424 \pm 34$ $401 \pm 32$ $385 \pm 31$ $363 \pm 29$ $355 \pm 28$ $333 \pm 27$	cf. 29-63a11	Thickness 3-35 mg/cm <sup>2</sup>		
					$\text{Ni}^{58}(n, p) \text{ Co}^{58m}$			
28-58b1m	P60 I	$9.0 \pm 0.2h$ * <sup>2</sup>	$14.8 \pm 0.9$	$40 \pm 15$		cf. 27-59a1g		
						cf. 28-58b1g		
					$\text{Ni}^{58}(n, pn + n, np + n, d) \text{ Co}^{57}$			
28-58c1	P59 II	270d	14.I	$160 \pm 40$		cf. 28-58a4		

\*<sup>1</sup> Measured for  $12 \text{ MeV} \leq E_n \leq 18.5 \text{ MeV}$

\*<sup>2</sup> Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
28-58c2	G62	270d		13.86 $\pm$ 0.10 14.11 $\pm$ 0.10 14.24 $\pm$ 0.10 14.37 $\pm$ 0.15 14.49 $\pm$ 0.20 14.59 $\pm$ 0.20 14.69 $\pm$ 0.25 14.77 $\pm$ 0.25 14.88 $\pm$ 0.30	490 $\pm$ 49 560 $\pm$ 56 520 $\pm$ 52 530 $\pm$ 53 600 $\pm$ 60 580 $\pm$ 58 560 $\pm$ 56 580 $\pm$ 58 580 $\pm$ 58		cf. 28-58a4	
28-58d1	A57 II	—	14.1	310 $\pm$ 60			cf. 13-27d1	
28-58d2 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) 440 $\pm$ 26 b) 430 $\pm$ 26			cf. 11-23d1	
28-58d3 diff.	S60	—	14.1	$2 \cdot \frac{d\sigma}{d\Omega} = 534 \pm 100$ for $d\Omega = 0^\circ - 180^\circ$			cf. 13-27d3	
28-58d4 diff.	G61 II	—	14.8 $\pm$ 0.3	$4\pi \left[ \frac{d\sigma}{d\Omega} \right] =$ a) 430 $\pm$ 18 for isotr. part b) 490 $\pm$ 21 for total Means for 10 angles between $0^\circ$ and $150^\circ$ with $d\Omega = \pm 7^\circ - \pm 4^\circ$	abs.: $\alpha$ -from $T(d, n)$ He <sup>4</sup> and proton-recoil-telescope	Telescope : 2 prop.-counters and CsI crystal in coincidence with $\alpha$ from $T(d, n)$ He <sup>4</sup> . Separation of $d, n$ processes. Separation of $n, p$ - and $n, np$ -processes by stat. theory. Protons with $E_p > 1.8$ MeV measured. Protons with $E_p < 1.8$ MeV computed by stat. theory	Mean total error	Ni <sup>58</sup> enriched : 95.6 %, 2.7 cm $\phi$ ; thickness 10 mg/cm <sup>2</sup>
28-58d5 diff.	K60 I	—	14.8 $\pm$ 0.8	$4\pi \left[ \frac{d\sigma}{d\Omega} \right] = 287 \pm 29$ Means for 8 angles between $0^\circ$ and $180^\circ$	abs.: $\alpha$ from $T(d, n)$ He <sup>4</sup>	8 nuclear plates cyl. arranged around the target. Separation of $n, p$ - and $n, np$ -processes by stat. theory. $\sigma$ probably contains $n, d$ -processes	—	Ni <sup>58</sup> enriched 99.6% ; thickness 17.3 mg/cm <sup>2</sup>

I	II	III	IV	V	VI	VII	VIII	IX
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**Ni<sup>58</sup>(n, np) Co<sup>57</sup>**

28-58e1	A57 II	—	14.1	220 $\pm$ 44		cf. 13-27d1
28-58e2 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ 343 $\pm$ 27		cf. 11-23d1
28-58e3 diff.	G61 II	—	14.8 $\pm$ 0.3	$4\pi \left[ \frac{d\sigma}{d\Omega} \right] = 340 \pm 30$ Means for 10 angles between 0° and 150°		cf. 28-58d4
28-58e4 diff.	K60 I	—	14.8 $\pm$ 0.8	$4\pi \left[ \frac{d\sigma}{d\Omega} \right] = 150 \pm 15$ Means for 8 angles between 0° and 180°		cf. 28-58d5

**Ni<sup>58</sup>(n, d) Co<sup>57</sup>**

28-58f1 diff.	G61 II	—	14.8 $\pm$ 0.3	$4\pi \left[ \frac{d\sigma}{d\Omega} \right] = 25 \pm 6$ Means for 10 angles between 0° and 150°	cf. 28-58d4
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**Ni<sup>60</sup>(n, p) Co<sup>60m</sup>**

58-60b1m	P60 I	10.5 $\pm$ 0.2 min*	14.8 $\pm$ 0.9	9 $\pm$ 2	cf. 27-59a1g	cf. 28-58b1g
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**Ni<sup>60</sup>(n, p) Co<sup>60</sup> + Ni<sup>60</sup>(n, pn) Co<sup>59</sup>**

28-60d1	A57 II	—	14.1	240 $\pm$ 50	cf. 13-27d1	
28-60d2 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) 124 $\pm$ 9 b) 134 $\pm$ 9	cf. 11-23d1	

\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
28-60d3 diff.	S60	—	14.1	$2 \cdot \frac{d\sigma}{d\Omega} = 158 \pm 32$ for $d\Omega = 0^\circ - 180^\circ$				
28-60d4 diff.	M58 II	—	$13.5 \pm 0.1$	87 for isotr. part 155 for total part		cf. 26-54d5		Ni <sup>60</sup> enriched 99.2 % ~ 1 cm <sup>2</sup> thickness 7 mg/cm <sup>2</sup>
$\text{Ni}^{60}(n, np) \text{ Co}^{59}$								
28-60e1	A57 II	—	14.1	$60 \pm 12$		cf. 13-27d1		
28-60e2 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ $51 \pm 10$		cf. 11-23d1		
28-60e3 diff.	M58 II	—	$13.5 \pm 0.1$	68		cf. 26-54d5		cf. 28-60d4
$\text{Ni}^{61}(n, p) \text{ Co}^{61}$								
28-61b1	P53	1.75 <i>h</i>	$14.5 \pm 0.35$	$181 \pm 25$		cf. 7-14a1		
28-61b2	P60 I	$1.70 \pm 0.05h^*$	$14.8 \pm 0.9$	$22 \pm 2$		cf. 27-59a1g		cf. 28-58b1g
$\text{Ni}^{61}(n, pn + n, np + n, d) \text{ Co}^{60m}$								
28-61clm	P60 I	$10.5 \pm 0.2$ min*	$14.8 \pm 0.8$	$3.8 \pm 1$		cf. 27-59a1g		cf. 28-58b1g
$\text{Ni}^{62}(n, p) \text{ Co}^{62g}$								
28-62b1g	P60 I	$13.8 \pm 0.2$ min*	$14.8 \pm 0.8$	$3.3 \pm 1$		cf. 27-59a1g		cf. 28-58b1g
$\text{Ni}^{62}(n, p) \text{ Co}^{62m}$								
28-62b1m	P60 I	$1.9 \pm 0.3$ min*	$14.8 \pm 0.8$	$2.0 \pm 0.5$		cf. 27-59a1g		cf. 28-58b1g

\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Ni}^{62}(n, pn + n, np + n, d) \text{Co}^{61}$								
28-62c2	P60 I	$1.70 \pm 0.05 h^*$	$14.8 \pm 0.8$	$0.65 \pm 0.15$		cf. 27-59a1g		cf. 28-58b1g
$\text{Ni}^{64}(n, p) \text{Co}^{64g}$								
28-64b1g	P60 I	$7.8 \pm 0.2 \text{ min}^*$	$14.8 \pm 0.8$	$< 4.1$		cf. 27-59a1g		cf. 28-58b1g
$\text{Ni}^{64}(n, p) \text{Co}^{64m}$								
28-64b1m	P60 I	$2.0 \pm 0.2$	$14.8 \pm 0.8$	$> 0.43$		cf. 27-59a1g		cf. 28-58b1g
$\text{Ni}^{nat}(n, p + n, pn) \text{Co}$								
28-d1 diff.	H62 III	—	$14.4 \pm 0.2$	$255 \pm 6 \text{ for}$ $E_p > 1.5 \text{ MeV}$		cf. 12-d1		
$\text{Ni}^{nat}(n, np) \text{Co}$								
28-e1 diff.	H62 III	—	$14.4 \pm 0.2$	$240 \pm 50 \text{ for}$ $E_p > 1.5 \text{ MeV}$		cf. 12-d1		
$\text{Ni}^{nat}(n, p + n, pn + n, np + n, d) \text{Co}$								
28-g1 diff.	V57	—	14	$4\pi \left[ \frac{d\sigma}{d\Omega} \right] = 170 \pm 20$ Means for $0 = 30^\circ$ , $45^\circ$ , $60^\circ$ , $90^\circ$ , $120^\circ$ , $135^\circ$ , $150^\circ$ and $E_p >$ $6 \text{ MeV}$		cf. 12-g1		

\*Measured by the authors

## C O P P E R

### $\text{Cu}^{63}(n, 2 n)\text{Cu}^{62}$

29-63a1	P53	10 min	$14.5 \pm 0.35$	$482 \pm 72$		cf. 7-14a1		
29-63a2	F52	9.9 min	14.1	$510 \pm 36$		cf. 13-27b2		
29-63a3	Y57	10.1 min	$14.1 \pm 0.15$	$556 \pm 28$		cf. 13-27b3		
29-63a4	B52 I	10 min	$14.25 \pm 0.25^{*1}$	$650 \pm 80$	rel. : cf. B51 $\sigma T(d, n) \text{He}^4$ for $E_d = 10.5 \text{ MeV}$	$\beta$ -activity, prop. counter, 2 $\pi$ geometry. Calibration with $\text{Cu}^{66} \sigma \text{Cu}^{65}(n, \gamma) \text{Cu}^{66}$ $= 560 \text{ mb}$ for therm. neutrons	Error contains : differences for several measurements; neutron flux ; calibration	Element : $2.54 \times 5.08 \text{ cm}$ ; thickness : 0.0127 cm
29-63a5	D60 I	10 min	14.6	$530 \pm 26$		cf. 8-16b5		Liquid scintillator Dioxane (201 gr) Naphthalene (14 gr) PPO (1 gr); $\text{H}_2\text{O}$ (5 gr); $\text{Cu}(\text{NO}_3)_2 \cdot 3 \text{H}_2\text{O}$ (0.967 gr)
29-63a6	P61 III	$9.8 \pm 0.2 \text{ min}^{*2}$	$14.1 \pm 0.1$	$490 \pm 45$		cf. 13-27b8		
29-63a7	F60	—	$13.77 \pm 0.20^{*3}$	$378 \pm 34$		cf. 7-14a7		
			$14.74 \pm 0.27$	$507 \pm 45$				
29-63a8	F50	10 min	$14^{*4}$	$330 \pm 66$	rel. : $\sigma D(d, n) \text{He}^3$	$\beta$ -activity, geiger-counter. Calibration with $\text{Cu}^{66}$ $\sigma \text{Cu}^{65}(n, \gamma) \text{Cu}^{66} = 560 \text{ mb}$ for therm. neutrons	—	Element
29-63a9	B62 I	$10.03 \pm 0.03 \text{ min}^{*2}$	$14.1 \pm 0.1^{*5}$	$509 \pm 56$	rel. : cf. 26-56b4 $\text{Fe}^{66}(n, p) \text{Mn}^{56} = 112.5 \text{ mb}$		cf. 13-27b8	
29-63a10	S61 II	$9.90 \pm 0.04 \text{ min}^{*2}$	$14.1 \pm 0.2$	$458 \pm 10$		cf. 13-27b11		

\*1 Also measured from threshold to 27 MeV

\*2 Measured by the authors

\*3 Also measured for  $12.5 \text{ MeV} \leq E_n \leq 18 \text{ MeV}$

\*4 Also measured from threshold to 14 MeV

\*5 Also measured for  $13 \text{ MeV} \leq E_n \leq 19.6 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
29-63a11	G62	—	13.86 $\pm$ 0.10 14.11 $\pm$ 0.10 14.37 $\pm$ 0.15 14.59 $\pm$ 0.20 14.77 $\pm$ 0.25	424 $\pm$ 21 455 $\pm$ 23 488 $\pm$ 24 519 $\pm$ 26 550 $\pm$ 27	abs. for $E_n = 14.77$ MeV $\propto$ from $T(d, n) \text{He}^4$	$\beta^+$ activity, 0.511 MeV annihilation radiation measured with 2 NaI crystals switched in coincidence	Standard deviation	Element, foils
29-63a12	M52		Relative measurement*1			$\beta$ -activity, geiger counter	—	—
29-63a13	C56			cf. 12-24b8*2				
				$\text{Cu}^{63}(n, p) \text{ Ni}^{63} + \text{Cu}^{63}(n, pn) \text{ Ni}^{62}$				
29-63d1	A57 II	—	14.1	120 $\pm$ 24		cf. 13-27d1		
29-63d2 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) 118 $\pm$ 9 b) 105 $\pm$ 10		cf. 11-23d1		
29-63d3 diff.	S60	—	14.1	$2 \cdot \frac{d\sigma}{d\Omega} = 149 \pm 30$ for $d\Omega = 0^\circ - 180^\circ$		cf. 13-27d3		
				$\text{Cu}^{63}(n, np) \text{ Ni}^{62}$				
29-63e1	A57 II	—	14.1	130 $\pm$ 26		cf. 13-27d1		
29-63e2 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ 152 $\pm$ 30		cf. 11-23d1		
				$\text{Cu}^{63}(n, \text{He}^3) \text{ Co}^{61}$				
29-63f1	B62 II	1.65h	14.7	< 0.08	—	—	—	—

\*1 Measured for 12 MeV  $\leq E_n \leq$  18.5 MeV

\*2 Measured for 12.5 MeV  $\leq E_n \leq$  17.5 MeV

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Cu}^{63}(n, \alpha) \text{Co}^{60m}$								
29-63ilm	K62	10.4 min	$14.8 \pm 0.4$	$23 \pm 3$		cf. 15-31a4		
$\text{Cu}^{65}(n, 2n) \text{Cu}^{64}$								
29-65a1	P53	12h	$14.5 \pm 0.35$	$1085 \pm 175$		cf. 7-14aI		Element
29-65a2	F52	12.8h	14.1	$970 \pm 80$		cf. 13-27b2		
29-65a3	R58 I	13.4h	14	935		cf. 7-14a2		
29-65a4	P61 I	12.68h* <sup>1</sup>	$13.88 \pm 0.10$ * <sup>2</sup>	$879 \pm 33$		cf. 22-46a2		
			$14.01 \pm 0.10$	$906 \pm 36$				
			$14.09 \pm 0.10$	$892 \pm 36$				
			$14.31 \pm 0.13$	$937 \pm 37$				
			$14.50 \pm 0.20$	$953 \pm 38$				
			$14.68 \pm 0.26$	$968 \pm 39$				
			$14.81 \pm 0.31$	$975 \pm 39$				
29-65a5	P61 III	$12.7 \pm 0.15$ h* <sup>1</sup>	$14.1 \pm 0.1$	$940 \pm 85$		cf. 13-27b8		
29-65a6	P59 I	$12.85 \pm 0.05$ h* <sup>1</sup>	$14.8 \pm 0.8$	$954 \pm 130$		cf. 13-27b4		
29-65a7	R61 II	$13.6 \pm 0.5$ h* <sup>1</sup>	$14.4 \pm 0.3$	$959 \pm 79$		cf. 7-14a7		Element
29-65a8	B61 IV	$12.75 \pm 0.04$ h* <sup>1</sup>	$14.1 \pm 0.1$ * <sup>3</sup>	$918 \pm 80$		cf. 13-27b8		
29-65a9	D60 II	—	$15 \pm 0.4$	$869 \pm 100$		cf. 26-56b11		
29-65a10	W60 II	12.87h	$14.5 \pm 0.5$	$1030 \pm 95$	rel. : cf. 29-63a $\text{Cu}^{63}(n, 2n) = 522 \text{ mb}$ Sandwich-method	$\gamma$ -activity. Measuring of the area under the photo- peak with a $2 \times 1 3/4''$ NaI crystal; calibration with Co <sup>58</sup> and Na <sup>22</sup>	—	—
29-65a11	G62	—	14.77	$995 \pm 70$		cf. 29-63a11		

\*<sup>1</sup> Measured by the author

\*<sup>2</sup> Also measured for  $10 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

\*<sup>3</sup> Also measured for  $13 \text{ MeV} \leq E_n \leq 19.6 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Cu}^{65}(n, p) \text{ Ni}^{65}$								
29-65b1	F52	2.56h	14.1	19 $\pm$ 4		cf. 13-27b2		Element $1\frac{1}{2}''$ $\varnothing$ , thickness 120 mg/cm <sup>2</sup>
29-65b2	S59 I	2.56h	14.8 $\pm$ 0.8	31 $\pm$ 13		cf. 17-37b2		Element 9.5-12.7 mm $\varnothing$ thickness 45 mg/cm <sup>2</sup>
29-65b3	P59 I	2.55 $\pm$ 0.20h* <sup>1</sup>	14.8 $\pm$ 0.8	27 $\pm$ 11		cf. 13-27b4		Element 1.7-2.1 cm $\varnothing$ thickness 3-6 mg/cm <sup>2</sup>
29-65b4	P61 III	2.6 $\pm$ 0.3h* <sup>1</sup>	14.1 $\pm$ 0.1	29 $\pm$ 5		cf. 13-27b8		CuO, powder
29-65b5	M61 II	—	14.8	29 $\pm$ 3		cf. 11-23i2		
29-65b6	D60 II	—	15 $\pm$ 0.4	17 $\pm$ 4		cf. 26-56b7		
29-65b7	Z56	—	14.0	$\sim$ 20	—	—	—	—
29-65b8	B62 II	2.6h	14.7	29.3 $\pm$ 3.2	—	—	—	—
$\text{Cu}^{65}(n, p) \text{ Ni}^{65} + \text{Cu}^{65}(n, pn) \text{ Ni}^{64}$								
29-65d1	A57 II	—	14.1	40 $\pm$ 8		cf. 12-37d1		
29-65d2 diff.	S60	—	14.1	$2 \cdot \frac{d\sigma}{d\Omega} = 30 \pm 6$ for $d\Omega = 0^\circ - 180^\circ$		cf. 13-27d3		
$\text{Cu}^{65}(n, \alpha) \text{ Co}^{62g}$								
29-65i1g	K62	13.9 min	14.8 $\pm$ 0.4	7.5 $\pm$ 2		cf. 15-31a4		

\*<sup>1</sup> Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Cu}^{65}(n, nz) \text{ Co}^{61}$								
29-65k1	B62 I	$99.6 \pm 2$ min* <sup>1</sup>	$14.1 \pm 0.1$ * <sup>2</sup>	$5.8 \pm 2$		cf. 13-27b8		
29-65k2	K62	$1.65h$	$14.8 \pm 0.4$	$2.8 \pm 0.3$		cf. 15-31a4		
29-65k3	B62 II	$1.6h$	$14.7$	$2.9 \pm 0.8$	—	—	—	—
$\text{Cu}^{nat}(n, 2n) \text{ Cu}$								
29-a1	A58 II	—	14.1	$760 \pm 60$		cf. 1-2aI	Element	
$\text{Cu}^{nat}(n, p + n, pn) \text{ Ni}$								
29-d1 diff.	A59	—	14.1	a) $4 \cdot \frac{d\sigma}{d\Omega} = 98$ for $d\Omega = 90^\circ - 180^\circ$ b) $2 \cdot \frac{d\sigma}{d\Omega} = 118$ for $d\Omega = 0^\circ - 180^\circ$		cf. 26-54d2	Element	
29-d2 diff.	C59 I	—	14.5	$4\pi \left[ \frac{d\sigma}{d\Omega} \right] = 46 \pm 5$ ; means for $\theta = 180^\circ, 45^\circ, 90^\circ, 135^\circ$ and $d\Omega = 18^\circ$	abs. : proton recoil telescope	Telescope, 2 prop. counters in coincidence with a CsI crystal and in anti-coincidence with a prop. counter before the target. Separation of $n,p$ - and $n,np$ -processes by stat. theory. $\sigma$ probably contains $n, d$ -processes	—	—

\*<sup>1</sup> Measured by the authors

\*<sup>2</sup> Also measured from threshold to 19.6 MeV

I	II	III	IV	V	VI	VII	VIII	IX
<b>Cu<sup>nat</sup>(n, np) Ni</b>								
29-el diff.	A59	—	14.1	128		cf. 26-54d2		Element
29-e2 diff.	C59 I	—	14.5	$4\pi \left[ \frac{d\sigma}{d\theta} \right] = 181 \pm 18,$ means for $\theta = 180^\circ,$ $45^\circ, 90^\circ, 135^\circ$ and $d\theta$ $= 18^\circ$		cf. 29-d2		

## ZIN C

 $Zn^{64}(n, 2n) Zn^{63}$ 

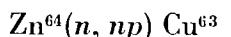
								Element
30-64a1	P53	38 min	$14.5 \pm 0.35$	$224 \pm 45$		cf. 7-14a1		
30-64a2	Y57	38.5 min	$14.1 \pm 0.15$	$119 \pm 18$		cf. 13-27b3		
30-64a3	P60 I	$36 \pm 0.2$ min* <sup>1</sup>	$14.8 \pm 0.9$	$254 \pm 50$		cf. 27-59alg		Element, discs ; thickness 3-35 mg/cm <sup>2</sup>
30-64a4	R58 I	39.9 min	14	159		cf. 7-14a1		
30-64a5	R61 I	—	13.5	75		cf. 7-14a7		
30-64a5	R61 II	$39.9 \pm 0.8$ min* <sup>1</sup>	$14.4 \pm 0.3$	$167 \pm 13$		cf. 7-14a7		Element
30-64a6	G61 IV	—	14* <sup>2</sup> 14.5 15	120 $\pm$ 10 180 $\pm$ 15 230 $\pm$ 15	—	—	—	—
30-64a7	W62	38 min	$13.86 \pm 0.10$ $14.11 \pm 0.10$ $14.37 \pm 0.15$ $14.59 \pm 0.20$ $14.77 \pm 0.25$	96 $\pm$ 8 107 $\pm$ 9 136 $\pm$ 11 165 $\pm$ 13 182 $\pm$ 15		cf. 29-63a11		
30-64a8	K60 II	38 min	Relative measurement* <sup>1</sup> . Exp. curve was fitted by $\sigma = 167$ mb for $E_n = 14.4$ MeV (cf. 30-64a5)		$\beta$ -activity, geiger counter	—	Element, nat ; thickness $\approx$ range of the $\beta$	

 $Zn^{64}(n, p) Cu^{64}$ 

						Element
30-64b1	P53	12h	$14.5 \pm 0.35$	$386 \pm 58$	cf. 7-14a1	
30-64b2	P60 I	$13.0 \pm 0.2h$ * <sup>1</sup>	$14.8 \pm 0.9$	$284 \pm 20$	cf. 27-59alg	Element, discs ; thickness 3-35 mg/cm <sup>2</sup>

<sup>\*1</sup> Measured by the authors<sup>\*2</sup> Also measured for  $13$  MeV  $\leq E_n \leq 17.6$  MeV

I	II	III	IV	V	VI	VII	VIII	IX
30-64b3	R61 I	—	13.5	215		cf. 30-64b3		
30-64b4	Z56	—	14.0	~216		cf. 30-66b4		
30-64b5	W62	12.85h	13.86 ± 0.10 14.11 ± 0.10 14.37 ± 0.15 14.59 ± 0.20 14.77 ± 0.25	190 ± 15 191 ± 15 177 ± 14 164 ± 13 155 ± 12		cf. 29-63a11		
30-64b6	G61 IV	—	14* <sup>1</sup> 14.25 14.5 14.75 ± 0.1 15 ± 0.1	220 ± 20 188 ± 15 220 ± 20 182 ± 16 196 ± 15	—	—	—	—
30-64b7	C56			cf. 12-24b8* <sup>2</sup>				
$\text{Zn}^{64}(n, p) \text{ Cu}^{64} + \text{Zn}^{64}(n, pn) \text{ Cu}^{63}$								
30-64d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) 179 ± 18 b) 171 ± 17		cf. 11-23d1		
30-64d2 diff.	S60	—	14.1	$2 \cdot \frac{d\sigma}{d\Omega} = 257 \pm 50$ for $d\Omega = 0^\circ - 180^\circ$		cf. 13-27d3		
30-64d3 diff.	R56 II	—	14	~295	—	Nuclear plate	—	—



30-64e1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ 281 ± 18	cf. 11-23d1
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\*<sup>1</sup> Also measured for  $12.4 \text{ MeV} \leq E_n \leq 17.5 \text{ MeV}$

\*<sup>2</sup> Measured for  $12.5 \text{ MeV} \leq E_n \leq 17.5 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
$Zn^{66}(n, 2n) Zn^{65}$								
30-66a1	H62 I	—	14.9	$530 \pm 130$	cf. 20-48a1	K-electron capture in prop. counter	ef. 20-48a1	
$Zn^{66}(n, p) Cu^{66}$								
30-66b1	P53	5 min	$14.5 \pm 0.35$	$101 \pm 17$		cf. 7-14a1		Element
30-66b2	Y57	5.13 min	$14.1 \pm 0.15$	$60.2 \pm 7.2$		cf. 13-27b3		
30-66b3	P60 I	$5.2 \pm 0.3$ min*	$14.8 \pm 0.9$	$77 \pm 10$		cf. 27-59alg		cf. 30-64b2
30-66b4	Z56	—	—	$\sim 80$	—	—	—	—
$Zn^{66}(n, p) Cu^{66} + Zn^{66}(n, pn) Cu^{65}$								
30-66d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) $34 \pm 4$ b) $35 \pm 4$		cf. 11-23d1		
$Zn^{66}(n, np) Cu^{65}$								
30-66e1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ $50 \pm 4$		cf. 11-23d1		
$Zn^{67}(n, p) Cu^{67} + Zn^{67}(n, pn) Cu^{66}$								
30-67d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$ a) $41 \pm 7$ b) $33 \pm 7$		cf. 11-23d1		

\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Zn}^{68}(n, p) \text{ Cu}^{68}$								
30-68b1	P60 I	$36 \pm 5$ sec*	$14.8 \pm 0.9$	$25 \pm 10$		cf. 27-59alg		cf. 30-64b2
$\text{Zn}^{68}(n, z) \text{ Ni}^{65}$								
30-68i1	P60 I	$2.25 \pm 0.02h^*$	$14.8 \pm 0.9$	$51 \pm 10$		cf. 27-59alg		cf. 30-64b2
30-68i2	B55 III	$2.56h$	$14.05 \pm 0.55$	$7.6 \pm 0.8$		cf. 27-59i3		
$\text{Zn}^{70}(n, n'z) \text{ Ni}^{66}$								
30-68k1	B62 II	$55h$	$14.7$	$0.89 \pm 0.40$				
$\text{Zn}^{nat}(n, p + n, pn + n, np + n, d) \text{ Cu}$								
30-g1 diff.	I162 III	—	$14.4 \pm 0.2$	$170 \pm 20$ for $E_p > 2.2$ MeV		cf. I2-d1		

\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
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## G A L L I U M

### $\text{Ga}^{69}(n, 2n) \text{ Ga}^{68}$

31-69a1	P53	68 min	$14.5 \pm 0.35$	$552 \pm 155$		cf. 7-14a1		Element
31-69a2	R58 I	69.2 min	14	1089		cf. 7-14a2		
31-69a3	R61 II	$69.2 \pm 1.4$ min <sup>*1</sup>	$14.4 \pm 0.3$	$923 \pm 70$		cf. 7-14a7		Element
31-69a4	K61 II	67.5 min	$14.8 \pm 0.5$	$1070 \pm 107$		cf. 17-35a5m		

### $\text{Ga}^{69}(n, p) \text{ Zn}^{69m}$

31-69b1m	P53	14h	$14.5 \pm 0.35$	$24.4 \pm 20$		cf. 7-14a1		Element
31-69b2m	B62 I	13.8h	$15 \pm 0.5^{*2}$	$42 \pm 4$	rel. : cf. 13-27i $\text{Al}^{27}(n, \alpha) = 118$ mb	cf. 13-27b8		

### $\text{Ga}^{69}(n, \alpha) \text{ Cu}^{66}$

31-69i1	P53	5 min	$14.5 \pm 0.35$	$105 \pm 58$		cf. 7-14a1		
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### $\text{Ga}^{71}(n, 2n) \text{ Ga}^{70}$

31-71a1	P53	20 min	$14.5 \pm 0.35$	$700 \pm 100$		cf. 7-14a1		Element
31-71a2	K61 II	21.0 min	$14.8 \pm 0.5$	$2180 \pm 218$		cf. 17-35a5m		

### $\text{Ga}^{71}(n, n\alpha) \text{ Cu}^{67}$

31-71k1	B62 I	$59.6 \pm 0.6h^{*1}$	$15.2 \pm 0.5$	$6 \pm 2^{*3}$	rel. : cf. 13-27i $\text{Al}^{27}(n, \alpha) = 118$ mb		cf. 13-27b8	
31-71k2	B62 II	61h	14.7	$2 \pm 1$	—	—	—	—

<sup>\*1</sup> Measured by the authors

<sup>\*2</sup> Also measured for  $15 \text{ MeV} \leq E_n \leq 19.6 \text{ MeV}$

<sup>\*3</sup> Also measured for  $15.2 \text{ MeV} \leq E_n \leq 19.6 \text{ MeV}$



## G E R M A N I U M

### $\text{Ge}^{70}(n, 2n) \text{ Ge}^{69}$

32-70a1	P53	<i>40h</i>	$14.5 \pm 0.35$	$666 \pm 230$		cf. 7-14a1	Element
32-70a2	R59 I	<i>36.9h</i>	$14$	$604 \pm 48$		cf. 17-35a3m	
32-70a3	R61 II	$38.6 \pm 0.8h^{*1}$	$14.4 \pm 0.3$	$598 \pm 45$		cf. 7-14a7	$\text{GeO}_2$
32-70a4	P61 I	<i>40.4h</i>	$13.83 \pm 0.10^{*2}$ $14.01 \pm 0.10$ $14.31 \pm 0.13$ $14.50 \pm 0.20$ $14.68 \pm 0.26$ $14.83 \pm 0.31$ $14.93 \pm 0.36$	$509 \pm 15$ $508 \pm 15$ $607 \pm 18$ $621 \pm 19$ $664 \pm 20$ $716 \pm 21$ $681 \pm 20$		cf. 22-46a2	
32-70a5	K61 II	<i>41.0h</i>	$14.8 \pm 0.5$	$1600 \pm 240$		cf. 17-35a5m	

### $\text{Ge}^{70}(n, p) \text{ Ga}^{70}$

32-70b1	P53	<i>20 min</i>	$14.5 \pm 0.35$	$129 \pm 60$		cf. 7-14a1	Element
32-70b2	Z56	—	—	$\sim 93$	—	—	—

### $\text{Ge}^{72}(n, p) \text{ Ga}^{72}$

32-72b1	P53	<i>14h</i>	$14.5 \pm 0.35$	$65.2 \pm 26$		cf. 7-14a1	Element
32-72b2	Z56	—	—	$\sim 32$	—	—	—

### $\text{Ga}^{73}(n, p) \text{ Ga}^{73}$

32-73b1	P53	<i>5h</i>	$14.5 \pm 0.35$	$136.6 \pm 70$		cf. 7-14a1	Element
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\*1 Measured by the authors

\*2 Also measured for  $11.8 \text{ MeV} \leq E_n \leq 19.7 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Ge}^{74}(n, \alpha) \text{Zn}^{71}$								
32-74 <i>i</i> 1	P53	2.2 min	$14.5 \pm 0.35$	$14.9 \pm 6$		cf. 7-14 <i>a</i> 1	—	Element
$\text{Ge}^{76}(n, 2n) \text{Ge}^{75}$								
32-76 <i>a</i> 1	P53	82 min	$14.5 \pm 0.35$	$1820 \pm 550$		cf. 7-14 <i>a</i> 1		Element
32-76 <i>a</i> 2	K61 II	78 min	$14.8 \pm 0.5$	$1200 \pm 240$		cf. 17-35 <i>a</i> 3 <i>m</i>		
$\text{Ge}^{76}(n, n\alpha) \text{Zn}^{72}$								
32-76 <i>k</i> 1	B62 II	49 <i>h</i>	14.7	< 2	—	—	—	—

## A R S E N I C

### $\text{As}^{75}(n, 2n) \text{ As}^{74}$

33-75a1	P61 I	17.8* <sup>1</sup>		14.01 $\pm$ 0.10* <sup>2</sup>	1070 $\pm$ 43			
				14.31 $\pm$ 0.13	1113 $\pm$ 45			cf. 22-46a2
				14.68 $\pm$ 0.26	1149 $\pm$ 46			
				14.93 $\pm$ 0.36	1123 $\pm$ 45			
33-75a2	P53	17d		14.5 $\pm$ 0.35	545 $\pm$ 160		cf. 7-14a1	Element

### $\text{As}^{75}(n, p) \text{ Ge}^{75}$

33-75b1	P61 IV	—	14.01 $\pm$ 0.10* <sup>3</sup>	20.7 $\pm$ 1.5			
			14.31 $\pm$ 0.13	19.3 $\pm$ 1.4			cf. 22-46a2
			14.54 $\pm$ 0.20	18.1 $\pm$ 1.3			
			14.93 $\pm$ 0.36	15.9 $\pm$ 1.2			
33-75b2	P53	8.2 min	14.5 $\pm$ 0.35	11.8 $\pm$ 2.4		cf. 7-14a1	Element

### $\text{As}^{75}(n, p) \text{ Ge}^{75g}$

33-75b1g	F61 II	—	14.1 $\pm$ 0.2	25 $\pm$ 5			
						cf. 13-27b12	

### $\text{As}^{75}(n, p) \text{ Ge}^{75m}$

33-75b1m	F61 II	—	14.1 $\pm$ 0.2	10 $\pm$ 2			
						cf. 13-27b12	

### $\text{As}^{75}(n, p) \text{ Ge}^{75} + \text{As}^{75}(n, pn) \text{ Ge}^{74}$

33-75d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$			
				27 $\pm$ 5		cf. I1-23d1	

\*<sup>1</sup> Measured by the authors

\*<sup>2</sup> Also measured for  $10.3 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

\*<sup>3</sup> Also measured for  $7 \text{ MeV} \leq E_n \leq 14.9 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
$\text{As}^{75}(n, \text{He}^3) \text{ Ga}^{73}$								
33-75f1	B62 II	5h		14.7	< 0.51	—	—	—
$\text{As}^{75}(n, p) \text{ Ge}^{75} + \text{As}^{75}(n, pn + n, np + n, d) \text{ Ge}^{74}$								
33-75g1	A58 III	—	14		115 $\pm$ 15	cf. 25-55g1	—	—
$\text{As}^{75}(n, 2p) \text{ Ga}^{74}$								
33-75h1	B62 II	7.8 min		14.7	< 0.50	—	—	—
$\text{As}^{75}(n, \alpha) \text{ Ga}^{72}$								
33-75i1	P53	14h		14.5 $\pm$ 0.35	12.3 $\pm$ 2.2	cf. 7-14a1	Element	
33-75i2	P61 IV	—		14.01 $\pm$ 0.10*	9.8 $\pm$ 0.7	cf. 22-46a2		
				14.31 $\pm$ 0.13	10.4 $\pm$ 0.7			
				14.68 $\pm$ 0.23	10.2 $\pm$ 0.7			
				14.93 $\pm$ 0.36	10.0 $\pm$ 0.7			
33-75i3	F61 I	—		14.8	4.59	—	—	—
33-75i4	P62	14h		14.7	9.3 $\pm$ 3.1	—	—	—

\* Also measured for 7 MeV  $\leq E_n \leq$  19.8 MeV

I

II

III

IV

V

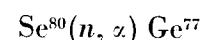
VI

VII

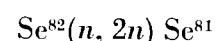
VIII

IX

## S E L E N I U M



34-80 <i>a</i> I	P53	59 sec; 12 h	$14.5 \pm 0.35$	$37.7 \pm 15.4$	cf. 7-14 <i>a</i> 1	Element
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34-82 <i>a</i> I	P53	59 min	$14.5 \pm 0.35$	$1500 \pm 500$	cf. 7-14 <i>a</i> 1	Element
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I

II

III

IV

V

VI

VII

VIII

IX

## B R O M I N E

### $\text{Br}^{79}(n, 2n) \text{ Br}^{78}$

35-79a1	P53	6.4 min	$14.5 \pm 0.35$	$1141 \pm 285$	cf. 7-14a1	LiBr; NaBr
35-79a2	R59 I	6.3 min	14	$788 \pm 63$	cf. 17-35a3m	
35-79a3	R61 II	$6.33 \pm 0.13$ min*	$14.4 \pm 0.3$	$835 \pm 63$	cf. 7-14a7	NaBr

### $\text{Br}^{79}(n, \alpha) \text{ As}^{76}$

35-79i1	B58	26.8h	$14.05 \pm 0.55$	$10 \pm 1.8$	cf. 27-59i3	
35-79i2	P62	27h	14.7	$10.8 \pm 2.4$	—	—

### $\text{Br}^{81}(n, 2n) \text{ Br}^{80} - \text{tot.}$

35-81a1t	S62	—	$14.6 \begin{array}{l} +0.2 \\ -0.3 \end{array}$	$1047 \pm 98$	cf. 37-87a1	
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### $\text{Br}^{81}(n, 2n) \text{ Br}^{80m}$

35-81a1m	P53	4.4h	$14.5 \pm 0.35$	$828 \pm 165$	cf. 7-14a1	LiBr; NaBr
35-81a2m	S62	—	$14.6 \begin{array}{l} +0.2 \\ -0.3 \end{array}$	$610 \pm 93$	cf. 37-87a1	
35-81a3m	R61 II	$4.49 \pm 0.09h^*$	$14.4 \pm 0.3$	$752 \pm 72$	cf. 7-14a7	NaBr
35-81a4m	F61 II	—	$14.2 \pm 0.2$	$510 \pm 56$	cf. 13-27b12	

### $\text{Br}^{81}(n, 2n) \text{ Br}^{80g}$

35-81a1g	S62	—	$14.6 \begin{array}{l} +0.2 \\ -0.3 \end{array}$	$437 \pm 29$	cf. 37-87a1	
35-81a2g	F61 II	—	$14.2 \pm 0.2$	$470 \pm 50$	cf. 13-27b12	

\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
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					$\text{Br}^{81}(n, p) \text{ Se}^{81} - \text{tot.}$			
35-81b1t	S62	—	14.6 $^{+0.2}_{-0.3}$	57 $\pm$ 10		cf. 38-86b2		
					$\text{Br}^{81}(n, p) \text{ Se}^{81m}$			
35-81b1m	S62	—	14.6 $^{+0.2}_{-0.3}$	32 $\pm$ 8		cf. 38-86b2		
					$\text{Br}^{81}(n, p) \text{ Se}^{81g}$			
35-81b1g	S62	—	14.6 $^{+0.2}_{-0.3}$	25 $\pm$ 5		cf. 38-86b2		
					$\text{Br}^{81}(n, z) \text{ As}^{78}$			
35-81i1	P53	90 min	14.5 $\pm$ 0.35	103 $\pm$ 20		cf. 7-14a1		LiBr, NaBr
35-81i2	S62	—	14.6 $^{+0.2}_{-0.3}$	107 $\pm$ 20		cf. 38-86b2		
35-81i3	P62	90 min	14.7	9.2 $\pm$ 1.2	—	—	—	—
					$\text{Br}^{81}(n, nz) \text{ As}^{77}$			
35-81k1	B62 II	39h	14.7	<1.0	—	—	—	—
					$\text{Br}^{nat}(n, p + n, pn) \text{ Se}$			
35-d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{12^{\circ}, 0} =$ $< 14$		cf. 11-23d1		

## R U B I D I U M

### $\text{Rb}^{85}(n, 2n) \text{ Rb}^{84}$

37-85a1	S62	—	$14.6 \begin{array}{l} +0.2 \\ -0.3 \end{array}$	$687 \pm 74$	cf. 37-87a1
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### $\text{Rb}^{85}(n, 2n) \text{ Rb}^{84} + \text{Rb}^{85}(n, 2n) \text{ Rb}^{84m}$

37-85a1+m	P61 I	33d	$14.09 \pm 0.10^{\ast 1}$	$1447 \pm 72$	$\sigma$ does not contain the cf. 22-46a2
			$14.50 \pm 0.20$	$1498 \pm 75$	decay of $\text{Rb}^{84m}$ by E. C.
			$14.68 \pm 0.26$	$1520 \pm 76$	
			$14.81 \pm 0.31$	$1530 \pm 77$	

### $\text{Rb}^{85}(n, \alpha) \text{ Br}^{82}$

37-85i1	S62	—	$14.6 \begin{array}{l} +0.2 \\ -0.3 \end{array}$	$143 \pm 9$	cf. 38-68b2
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37-85i2	P62	36h	14.7	145	—	—	—
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### $\text{Rb}^{87}(n, 2n) \text{ Rb}^{86}$

37-87a1	S62	—	$14.6 \begin{array}{l} +0.2 \\ -0.3 \end{array}$	$835 \pm 136$	rel.: cf. 26-56b $\text{Fe}^{56}(n, p) = 110$ mb or cf. 13-27i $\text{Al}^{27}(n, \alpha) = 115$ mb Sandwich method	$\beta$ - and $\gamma$ -activity. Cor- rections for abs. $\beta$ -counting ef. R56 III and Z50. $\gamma$ -rays were counted with a $3 \times 3''$ NaI crystal; efficiency cf. L56. Chem. separation	Total error, without deviations in the decay scheme Foils
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### $\text{Rb}^{87}(n, 2n) \text{ Rb}^{86} + \text{R}^{87}(n, 2n) \text{ Rb}^{86m}$

37-87a1+m	P61 I	18.66d	$14.09 \pm 0.10^{\ast 2}$	$1170 \pm 57$	$\sigma$ does not contain the cf. 22-46a2
			$14.50 \pm 0.20$	$1210 \pm 61$	decay of $\text{Rb}^{86m}$ by E. C.
			$14.68 \pm 0.26$	$1194 \pm 59$	
			$14.81 \pm 0.31$	$1191 \pm 59$	

<sup>\*1</sup> Also measured for  $10.5 \text{ MeV} \leq E_n \leq 19.6 \text{ MeV}$

<sup>\*2</sup> Also measured for  $10.0 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Rb}^{87}(n, \alpha) \text{ Br}^{84}$								
37-87 <i>i</i> 1	P53	33 min	14.5 $\pm$ 0.35	38.9 $\pm$ 16.3		cf. 7-14 <i>a</i> 1		$\text{Rb}_x\text{CO}_3$
37-87 <i>i</i> 2	S62	—	14.6 $^{+0.2}_{-0.3}$	59 $\pm$ 12		cf. 38-86 <i>b</i> 2		
$\text{Rb}^{87}(n, n\alpha) \text{ Br}^{83}$								
37-87 <i>k</i> 1	B62 II	2.3 <i>h</i>	14.7	< 1.5	—	—	—	—

I	II	III	IV	V	VI	VII	VIII	IX
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## S T R O N T I U M

### $\text{Sr}^{84}(n, 2n) \text{ Sr}^{83}$

38-84a1	P61 I	<i>33h</i>	13.88 $\pm$ 0.10*	115.9 $\pm$ 5.8			cf. 22-46a2	
			14.09 $\pm$ 0.10	142.4 $\pm$ 7.1				
			14.31 $\pm$ 0.13	149.9 $\pm$ 7.5				
			14.50 $\pm$ 0.20	171.7 $\pm$ 8.6				
			14.68 $\pm$ 0.28	176.8 $\pm$ 8.8				
			14.93 $\pm$ 0.36	180.6 $\pm$ 9.0				
38-84a2	S62	—	14.6 $^{+ 0.2}_{- 0.3}$	380 $\pm$ 50	rel. : cf. 26-56b Fe <sup>56</sup> (n, p) = 110 mb or cf. 13-27 <i>i</i> Al <sup>27</sup> (n, $\alpha$ ) = 115 mb Sandwich method	$\gamma$ -activity : 3 $\times$ 3" NaI crystal. Efficiency cf. L56	Total error without deviations in the decay scheme	Foils
38-84a3	K61 II	<i>33h</i>	14.8 $\pm$ 0.5	1770 $\pm$ 180		cf. 17-35a5 <i>m</i>		
38-84a4	P62	<i>33h</i>	14.7	140 $\pm$ 80	—	—	—	—

### $\text{Sr}^{86}(n, 2n) \text{ Sr}^{85g}$

38-86a1g	M61 I	<i>65d</i>	14.1	680 $\pm$ 109		cf. 38-86a1 <i>m</i>		
38-86a2g	S62	—	14.6 $^{+ 0.2}_{- 0.3}$	280 $\pm$ 10		cf. 38-84a2		

### $\text{Sr}^{86}(n, 2n) \text{ Sr}^{85m}$

38-86a1m	M61 I	70 min	14.1	21 $\pm$ 8	rel. : cf. 13-27 <i>i</i> 10 Al <sup>27</sup> (n, $\alpha$ ) = 116 mb	$\gamma$ -activity, 1 $\frac{1}{2} \times 1''$ NaI-crystal. Efficiency cf. K54. Corrections for geometry, backscattering etc. exp. determinated	Total error	SrCO <sub>3</sub> powder
38-86a2m	S62	—	14.6 $^{+ 0.2}_{- 0.3}$	312 $\pm$ 50		cf. 38-84a2		

\* Also measured for 12 MeV  $\leq$  E<sub>n</sub>  $\leq$  19.8 MeV

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Sr}^{86}(n, p) \text{ Rb}^{86}$								
38-86b1	P61 IV	—	14.01 $\pm$ 0.10*	42.5 $\pm$ 4.0		cf. 22-46a2		
			14.31 $\pm$ 0.13	43.5 $\pm$ 4.4				
			14.68 $\pm$ 0.26	41.5 $\pm$ 3.7				
			14.93 $\pm$ 0.36	45.3 $\pm$ 4.0				
38-86b2	S62	—	14.6 $^{+0.2}_{-0.3}$	64 $\pm$ 7	rcl.; cf. 26-56b Fe <sup>56</sup> (n, p) = 110 mb or cf. 13-27i Al <sup>27</sup> (n, $\alpha$ ) = 115 mb Sandwich method	$\beta$ -activity, Corrections for abs. $\beta$ -counting cf. R56III and Z50. Chem. sepa- ration	Total error without deviations in the decay scheme	Foils
$\text{Sr}^{88}(n, 2n) \text{ Sr}^{87}$								
38-88a1	S62	—	14.6 $^{+0.2}_{-0.3}$	215 $\pm$ 24		cf. 38-84a2		
$\text{Sr}^{88}(n, p) \text{ Rb}^{88}$								
38-88b1	P53	17 min	14.5 $\pm$ 0.35	17.7 $\pm$ 3.5		cf. 7-14a1		$\text{SrCO}_3$
38-88b2	S62	—	14.6 $^{+0.2}_{-0.3}$	30 $\pm$ 2		cf. 38-86b2		
38-88b3	B62 II	18 min	14.7	11 $\pm$ 3	—	—	—	—
$\text{Sr}^{88}(n, \alpha) \text{ Kr}^{85m}$								
38-88i1m	P53	4.5h	14.5 $\pm$ 0.35	64 $\pm$ 20	—	cf. 7-14a1		$\text{SrCO}_3$
38-88i2m	S62	—	14.6 $^{+0.2}_{-0.3}$	87 $\pm$ 31	—	cf. 38-86b2		
$\text{Sr}^{nat}(n, p) \text{ Rb} + \text{Sr}^{nat}(n, pn) \text{ Rb}$								
38-d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{v_2=0} =$ 22 $\pm$ 17	—	cf. 11-23d1		

\* Also measured for 13.4 MeV  $\leq E_n \leq$  14.93 MeV

I	II	III	IV	V	VI	VII	VIII	IX
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### Y T T R I U M

#### $\text{Y}^{89}(n, 2n) \text{ Y}^{88}$

39-89a1	M61 I	—	14.1	$540 \pm 80$	—	cf. 38-86alm	—	—
39-89a2	T60	—	13.9 <sup>*1</sup>	585	—	—	—	—
			14.0	680				
			14.6	685				
			15.1	1005				
39-89a3	S62	—	$14.6 \begin{matrix} +0.2 \\ -0.3 \end{matrix}$	$542 \pm 58$	—	cf. 38-84a2	—	—
39-89a4	P61 IV	—	Relative measurement <sup>*2</sup>	—	—	cf. 22-46a2	—	—

#### $\text{Y}^{89}(n, 2n) \text{ Y}^{88m}$

39-89alm	G61 I	$14 \pm 1 \text{ msec}^{*3}$	14.5	$> 400$	—	cf. 49-115alm	—	—
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#### $\text{Y}^{89}(n, p) \text{ Sr}^{89}$

39-89b1	P61 IV	—	$14.01 \pm 0.10^{*4}$	$23.7 \pm 1.7$	—	cf. 22-46a2	—	—
			$14.09 \pm 0.10$	$22.7 \pm 1.6$				
			$14.31 \pm 0.13$	$24.1 \pm 1.7$				
			$14.54 \pm 0.20$	$24.0 \pm 1.7$				
			$14.68 \pm 0.26$	$24.5 \pm 1.8$				
			$14.81 \pm 0.31$	$23.4 \pm 1.7$				
			$14.93 \pm 0.36$	$23.2 \pm 1.7$				
39-89b2	T60	—	13.9 <sup>*5</sup>	$14 \pm 3$	—	—	—	—
			14.0	$14.5 \pm 3$				

<sup>\*1</sup> Also measured for  $12.2 \text{ MeV} \leq E_n \leq 15.1 \text{ MeV}$

<sup>\*2</sup> Measured for  $11.5 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

<sup>\*3</sup> Measured by the authors

<sup>\*4</sup> Also measured for  $7 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

<sup>\*5</sup> Also measured for  $8.2 \text{ MeV} \leq E_n \leq 14.0 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Y}^{89}(n, 2n) \text{ Rb}^{88}$								
39-89 <i>h</i> 1	B62 II	18 min	14.7	< 0.020	—	—	—	—
$\text{Y}^{89}(n, z) \text{ Rb}^{86}$								
39-89 <i>i</i> 1	P53	19 <i>d</i>	14.5 ± 0.35	69.7 ± 42	—	cf. 7-14 <i>a</i> 1	—	—
39-89 <i>i</i> 2	P61 IV	—	14.01 ± 0.10* <sup>1</sup> 14.31 ± 0.13 14.50 ± 0.20 14.81 ± 0.31	5.0 ± 0.5 5.5 ± 0.5 5.0 ± 0.5 5.4 ± 0.5	—	cf. 22-46 <i>a</i> 2	—	—
39-89 <i>i</i> 3	S62	—	14.6 <sup>+0.2</sup> — <sub>0.3</sub>	96 ± 24	—	cf. 38-86 <i>b</i> 2	—	—
39-89 <i>i</i> 4	T60	—	13.9* <sup>2</sup> 14.0	1.6 ± 0.3 2.0 ± 0.3	—	—	—	—

\*<sup>1</sup> Also measured for 13.4 MeV ≤ E<sub>n</sub> ≤ 14.8 MeV

\*<sup>2</sup> Also measured for 8.2 MeV ≤ E<sub>n</sub> ≤ 14.0 MeV

## Z I R C O N I U M

### $Zr^{90}(n, 2n) Zr^{89}$

40-90a1	P61 I	79.3h	13.88 $\pm$ 0.10* <sup>1</sup> 14.01 $\pm$ 0.10 14.09 $\pm$ 0.10 14.31 $\pm$ 0.13 14.50 $\pm$ 0.20 14.68 $\pm$ 0.26 14.81 $\pm$ 0.31 14.93 $\pm$ 0.36	585 $\pm$ 18 604 $\pm$ 18 623 $\pm$ 19 716 $\pm$ 21 768 $\pm$ 23 822 $\pm$ 25 838 $\pm$ 25 856 $\pm$ 26	cf. 22-46a2			
40-90a2	S62	—	14.6 $\begin{array}{l} + 0.2 \\ - 0.3 \end{array}$	502 $\pm$ 36	—	cf. 38-84a2		
40-90a3	R60	—	14.1	470 $\pm$ 22	—	Scintillation counter	—	—

### $Zr^{90}(n, 2n) Zr^{89m}$

40-90a1m	P53	4.5 min	14.5 $\pm$ 0.35	$> 79.8 \pm 40$	—	cf. 7-14a1	Zr(NO <sub>3</sub> ) <sub>2</sub>	Element
40-90a2m	P62	4.4 min	14.7	84	—	—	—	—
40-90a3m	R60	—	14.1	74 $\pm$ 3	—	cf. 40-90a3	—	—

### $Zr^{90}(n, 2n) Zr^{89} + Zr^{90}(n, 2n) Zr^{89m}$

40-90a1+m	R61 II	79.4 $\pm$ 1.6h* <sup>2</sup>	14.4 $\pm$ 0.3	677 $\pm$ 51	—	cf. 7-14a7		
40-90a2+m	R60	—	14.1	544 $\pm$ 22	—	cf. 40-90a3		

### $Zr^{90}(n, p) Y^{90}$

40-90b1	P53	61h	14.5 $\pm$ 0.35	247 $\pm$ 100	—	cf. 7-14a1	Zr(NO <sub>3</sub> ) <sub>2</sub>	Element
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\*<sup>1</sup> Also measured for 12 MeV  $\leq E_n \leq$  19.8 MeV

\*<sup>2</sup> Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
40-90b2	P61 IV	—	14.01 $\pm$ 0.10* <sup>1</sup> 14.09 $\pm$ 0.10 14.31 $\pm$ 0.13 14.50 $\pm$ 0.20 14.68 $\pm$ 0.26 14.81 $\pm$ 0.31 14.93 $\pm$ 0.36	45 $\pm$ 2.5 44.5 $\pm$ 2.5 48 $\pm$ 2.5 46.5 $\pm$ 2.5 45 $\pm$ 2.0 45 $\pm$ 2.0 44.5 $\pm$ 2.0		cf. 22-46a2		
40-90b3	S62	—	14.6 $\pm$ 0.2 $\frac{+0.2}{-0.3}$	233 $\pm$ 29		cf. 38-86b2		
40-90b4	R60	—	14.1	43.1 $\pm$ 2.0		cf. 40-90a3		
$Zr^{90}(n, \alpha) Sr^{87m}$								
40-90i1m	P53	2.75h	14.5 $\pm$ 0.35	194 $\pm$ 110		cf. 7-14a1		Element
40-90i2m	B55 III	2.80h	14.05 $\pm$ 0.55	3.3 $\pm$ 0.6		cf. 27-59i3		
40-90i3m	B55 II	—	14.1	3.1 $\pm$ 0.2		cf. 29-63a4		
40-90i4m	R60	—	14.1	3.34 $\pm$ 0.16		cf. 40-90a3		
40-90i5m	P62	2.8h	14.7	2.8 $\pm$ 0.16	—	—	—	—
$Zr^{91}(n, p) Y^{91g}$								
40-91b1g	R60	—	14.1	14.2 $\pm$ 1.4		cf. 40-90a3		
$Zr^{91}(n, p) Y^{91m}$								
40-91b1m	R60	—	14.1	17.5 $\pm$ 0.8		cf. 40-90a3		
$Zr^{91}(n, p) Y^{91} - \text{tot.}$								
40-91b1t	S62	—	14.6 $\pm$ 0.2 $\frac{+0.2}{-0.3}$	180 $\pm$ 43		cf. 38-86b2		

\*<sup>1</sup> Also measured for 8 MeV  $\leq E_n \leq$  19.8 MeV

I	II	III	IV	V	VI	VII	VIII	IX
40-91b2t	B61 IV	—	14.8	~171	—	—	—	—
40-91b3t	S59 III	—	14.1	32	—	—	—	—
40-91b4t	R60	—	14.1	31.7 ± 1.4		cf. 40-90a3		
$\text{Zr}^{92}(n, p) \text{ Y}^{92}$								
40-92b1	S62	—	14.6 $^{+ 0.2}_{- 0.3}$	76 ± 16		cf. 38-86b2		
40-92b2	B62 II	—	14.7	22 ± 4	—	—	—	—
40-92b3	R60	—	14.1	20.7 ± 0.9		cf. 40-90a3		
$\text{Zr}^{92}(n, \alpha) \text{ Sr}^{89}$								
40-92i1	P61 IV	—	14.01 ± 0.10*	9.5 ± 0.40		cf. 22-46a2		
			14.31 ± 0.13	9.95 ± 0.45				
			14.68 ± 0.26	10.3 ± 0.46				
			14.93 ± 0.36	10.2 ± 0.46				
40-92i2	R60	—	14.1	21.8 ± 1.7		cf. 40-90a3		
$\text{Zr}^{94}(n, p) \text{ Y}^{94}$								
40-94b1	P53	16.5 min	14.5 ± 0.35	10.6 ± 4.2		cf. 7-14a1		$\text{Zr}(\text{NO}_3)_2$ , Element
40-94b2	S62	—	14.6 $^{+ 0.2}_{- 0.3}$	48 ± 12		cf. 38-86b2		
40-94b3	S59 III	—	14.1	~11	—	—	—	—
40-94b4	B62 II	17 min	14.7	7 ± 4	—	—	—	—
40-94b5	R60	—	14.1	10.8 ± 0.6		cf. 40-93a3		

\* Also measured for  $13.4 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
$Zr^{94}(n, pn + n, np + n, d) Y^{93}$								
40-94 <i>c</i> 1	R60	—	14.1	$< 0.8 \pm 0.1$		cf. 40-90 <i>a</i> 3		
$Zr^{94}(n, \alpha) Sr^{91}$								
40-94 <i>i</i> 1	B55 III	9.7 <i>h</i>		$14.05 \pm 0.55$	$3.6 \pm 0.5$		cf. 27-59 <i>i</i> 3	
40-94 <i>i</i> 2	B55 II	—	14.1	$4.9 \pm 0.5$			cf. 29-63	
40-94 <i>i</i> 3	P61 IV	—		$13.88 \pm 0.10^*$	$5.0 \pm 0.4$		cf. 22-46 <i>a</i> 2	
				$14.01 \pm 0.10$	$5.1 \pm 0.4$			
				$14.31 \pm 0.13$	$5.7 \pm 0.4$			
				$14.50 \pm 0.20$	$5.5 \pm 0.4$			
				$14.68 \pm 0.26$	$6.0 \pm 0.4$			
				$14.93 \pm 0.36$	$6.2 \pm 0.4$			
40-94 <i>i</i> 4	R60	—	14.1	$3.99 \pm 0.16$		cf. 40-90 <i>a</i> 3		
40-94 <i>i</i> 5	P62	9.7 <i>h</i>		14.7	$4.3 \pm 1.1$	—	—	—
$Zr^{96}(n, p) Y^{96}$								
40-96 <i>b</i> 1	B61 VI	—	14.8	$< 5$	—	—	—	—
$Zr^{96}(n, \alpha) Sr^{93}$								
40-96 <i>i</i> 1	R60	—	14.1	$< 4.8 \pm 0.7$		cf. 40-93 <i>a</i> 3		
40-96 <i>i</i> 2	P62	7 min		14.7	$5 \pm 4$	—	—	—
$Zr^{nat}(n, 2n) Zr$								
40- <i>a</i> 1	S57	—	14.1	$610 \pm 100$ for $E_n > 0.5$ MeV $d\Omega = 4\pi$	abs. : $\alpha$ -from $T(d, n) He^4$	Nuclear plates ; plates cyl. arranged around cyl. tar- get ; recoil protons recorded. Plates shielded by a Fe-paraffin collimator	Estimated mean total error	Element, cylinder : $1 \frac{1}{2}'' \otimes ; 1 \frac{1}{2}''$ height

\* Also measured for  $12.1 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

I            II            III            IV            V            VI            VII            VIII            IX

Zr<sup>nat</sup>(n, p + n, pn) Y

40-dl diff.      A61      —      14.1       $4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} =$       cf. 11-23d1  
63  $\pm$  12



## NIOBIUM

### $\text{Nb}^{93}(n, 2n) \text{ Nb}^{92}g$

41-93a1g	G61 I	$10.0 \pm 0.3d^{*1}$	14.5	$560 \pm 62$		cf. 49-115alm			
41-93a2g	M61 I	$9.9 \pm 0.1d^{*1}$	14.1	$430 \pm 70$		cf. 38-86alm		Powder	$\text{Nb}_2\text{O}_5$
41-93a3g	B62 III	$10.1d$	$14.5 \pm 0.9$	$499 \pm 91$	rel. : cf. 29-63a3 $\text{Cu}^{63}(n, 2n) = 556$ mb cf. 29-65a6 $\text{Cu}^{65}(n, 2n) =$ 954 mb; cf. 13-27b4 $\text{Al}^{27}(n, \alpha) = 114$ mb Sandwich method	$\gamma$ -activity. $3 \times 3''$ NaI crystal : measuring of the area under the photopeak	Probable total error	Powder	
41-93a4g	P61 IV	—	Rel. measurement <sup>*2</sup>			cf. 22-46a2			
41-93a5g	T60	—	13.9 <sup>*3</sup> 14.0 14.6 15.1	385 395 410 420	—	—	—	—	—

### $\text{Nb}^{93}(n, 2n) \text{ Nb}^{92}m$

41-93alm	S62	—	$14.6 \begin{array}{l} + 0.2 \\ - 0.3 \end{array}$	$318 \pm 18$		cf. 38-84a2			
41-93a2m	B62 III	$13h$	$14.5 \pm 0.9$	$< 1.2$		cf. 41-93a3g			

### $\text{Nb}^{93}(n, \text{He}^3) \text{ Y}^{91}m$

41-93f1m	B62 II	51 min	14.7	$< 0.06$	—	—	—	—	—
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<sup>\*1</sup> Measured by the authors

<sup>\*2</sup> Measured for  $8.9 \text{ MeV} \leq E_n \leq 14.7 \text{ MeV}$

<sup>\*3</sup> Also measured for  $9.9 \text{ MeV} \leq E_n \leq 15.1 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
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$\text{Nb}^{93}(n, p) \text{ Zr}^{93} + \text{Nb}^{93}(n, pn + n, np + n, d) \text{ Zr}^{92}$								
41-93g1 diff.	V57	—	14	$4\pi \left[ \frac{d\sigma}{d\theta} \right] = 22 \pm 8$ means for $\theta = 30^\circ, 45^\circ, 60^\circ, 120^\circ, 135^\circ, 150^\circ$ and $E_p > 6 \text{ MeV}$		cf. 12-g1		
$\text{Nb}^{93}(n, 2p) \text{ Y}^{92}$								
41-93h1	B62 II	3.7h	14.7	$< 0.50$	—	—	—	—
$\text{Nb}^{93}(n, \alpha) \text{ Y}^{90g}$								
41-93i1g	B62 III	64h	$14.5 \pm 0.9$	$8.6 \pm 2.5$	cf. 41-93a3g	cf. 13-27b4	cf. 41-93a3g	
$\text{Nb}^{93}(n, \alpha) \text{ Y}^{90m}$								
41-93i1m	B62 III	3.02h	$14.5 \pm 0.9$	$5.9 \pm 2$	cf. 41-93a3g	$\beta + \gamma$ -activity. $\beta$ : cf. 13-27b4 $\gamma$ : cf. 41-93a3g	cf. 41-93a3g	
$\text{Nb}^{93}(n, \alpha) \text{ Y}^{90} - \text{tot.}$								
41-93i1t	B58	61h	$14.05 \pm 0.55$	$9.0 \pm 2.2$		cf. 27-59i3		
41-93i2t	P61 IV	—	$14.01 \pm 0.10^{*1}$ $14.31 \pm 0.13$ $14.50 \pm 0.20$ $14.68 \pm 0.31$	$9.3 \pm 0.5$ $9.4 \pm 0.5$ $9.5 \pm 0.5$ $9.4 \pm 0.5$		cf. 22-46a2		
$\text{Nb}^{93}(n, n\alpha) \text{ Y}^{89m}$								
41-93k1m	B62 III	$16.3 \pm 1.3$ sec <sup>*2</sup>	14.5 0.9	$2.5 \pm 1.1$		cf. 41-93a3g		

<sup>\*1</sup> Also measured for  $7 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

<sup>\*2</sup> Measured by the authors

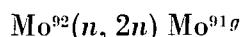
I	II	III	IV	V	VI	VII	VIII	IX
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## M O L Y B D E N U M

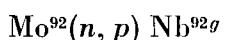


42-92a1g+m	R61 II	$15.2 \pm 0.3$ min* for Mo <sup>91g</sup>	$14.4 \pm 0.3$	$211 \pm 16$		cf. 7-14a7	Element
42-92a2g+m	P53	75 sec for Mo <sup>91m</sup> 15 min for Mo <sup>91g</sup>	$14.5 \pm 0.35$	$190 \pm 29$		cf. 7-14a1	Element
42-92a3g+m	Y57	16.3 min for Mo <sup>91g</sup>	$14.1 \pm 0.15$	$132 \pm 21$		cf. 13-27b4	
42-92a4g+m	B52	65 sec for Mo <sup>91m</sup> 15 min for Mo <sup>91g</sup>	$14.25 \pm 0.25$	$310 \pm 87$		cf. 29-63a4	Element $2.54 \times 5.08$ cm ; thickness 0.0127 cm

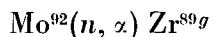
42-92a5g+m	R58 I	15.2 min for Mo <sup>91g</sup>	14	188		cf. 8-19a2
42-92a6g+m	S62	—	$14.6 \pm 0.2$	$315 \pm 35$		cf. 37-87a1



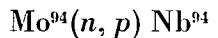
42-92a1g	P62	16 min	14.7	$198 \pm 40$	—	—	—
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42-92b1g	B62 III	9.9d	$14.5 \pm 0.9$	$58 \pm 30$		cf. 41-93a3g
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42-92a1g	B62 III	79h	$14.5 \pm 0.9$	$16 \pm 7$		cf. 41-93a3g
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42-94b1	B62 II	6.6 min	14.7	$6.0 \pm 1.5$	—	—	—
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\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Mo}^{96}(n, p) \text{ Nb}^{96}$								
42-96b1	S62	—	$14.6 \begin{array}{l} +0.2 \\ -0.3 \end{array}$	$21 \pm 7$	—	cf. 37-87a1	—	—
42-96b2	B62 II	26h	14.7	$36.6 \pm 0.2$	—	—	—	—
$\text{Mo}^{97}(n, p) \text{ Nb}^{97}$								
42-97b1	P53	76 min	$14.5 \pm 0.35$	$108 \pm 10$	—	cf. 7-14a1	Element	—
42-97b2	S62	—	$14.6 \begin{array}{l} +0.2 \\ -0.3 \end{array}$	$68 \pm 14$	—	cf. 37-87a1	—	—
42-97b3	B61 VI	—	14.8	$110 \pm 20$	—	—	—	—
$\text{Mo}^{98}(n, p) \text{ Nb}^{98}$								
42-98b1	B62 II	51 min	14.7	$9.0 \pm 1.5$	—	—	—	—
$\text{Mo}^{100}(n, 2n) \text{ Mo}^{99}$								
42-100a1	P53	68h	$14.5 \pm 0.35$	$3790 \pm 1900$	—	cf. 7-14a1	Element	—
42-100a2	S62	—	$14.6 \begin{array}{l} +0.2 \\ -0.3 \end{array}$	$2039 \pm 210$	—	cf. 37-87a1	—	—
24-10033	K61 II	67h	$14.8 \pm 0.5$	$1910 \pm 190$	—	cf. 17-35a5m	—	—
$\text{Mo}^{100}(n, z) \text{ Zr}^{97}$								
42-100i1	S62	—	$14.6 \begin{array}{l} +0.2 \\ -0.3 \end{array}$	$14 \pm 6$	—	cf. 38-86b2	—	—
$\text{Mo}^{nat}(n, p + n, pn) \text{ Nb}$								
42-d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} =$ $120 \pm 20$	—	cf. 11-23d1	—	—

I	II	III	IV	V	VI	VII	VIII	IX
42-d2 diff.	C59 I	—	14.5	$4\pi \left[ \frac{d\sigma}{d\theta} \right] = 31 \pm 3$ means for $\theta = 18^\circ, 45^\circ, 90^\circ, 135^\circ$ and $d\theta = 18^\circ$		cf. 29-d2		
42-el diff.	C59 I	—	14.5	$4\pi \left[ \frac{d\sigma}{d\theta} \right] = 112 \pm 11$ means for $\theta = 18^\circ, 45^\circ, 135^\circ$ and $d\theta = 18^\circ$		cf. 29-d2		

Mo<sup>nαt</sup>(n, np) Nb

## R U T H E N I U M

$\text{Ru}^{96}(n, 2n) \text{ Ru}^{95}$

44-96 <i>a</i> 1	P53	$1.6h$	$14.5 \pm 0.35$	$478 \pm 90$	cf. 7-14 <i>a</i> 1	$\text{RuO}_2$
44-96 <i>a</i> 2	K61 II	$1.6h$	14	$616 \pm 50$	cf. 17-35 <i>a</i> 5 <i>m</i>	
44-96 <i>a</i> 3	R61 II	$1.63 \pm 0.03^*$	$14.4 \pm 0.3$	$634 \pm 55$	cf. 7-14 <i>a</i> 7	Element

$\text{Ru}^{101}(n, p) \text{ Tc}^{101}$

44-101 <i>b</i> 1	P53	15 min	$14.5 \pm 0.35$	$199 \pm 140$	cf. 7-14 <i>a</i> 1	$\text{RuO}_2$
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\* Measured by the authors

I

II

III

IV

V

VI

VII

VIII

IX

## R H O D I U M

### Rh<sup>103</sup>(n, 2n) Rh<sup>102</sup>

45-103a1	T60	—	13.9*	730 ± 80	—	—	—	—
			14.0	740 ± 80				
			14.6	770 ± 80				
			15.I	790 ± 80				

### Rh<sup>103</sup>(n, He<sup>3</sup>) Tc<sup>101</sup>

45-103f1	B62 II	14 min	14.7	< 0.09	—	—	—	—
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### Rh<sup>103</sup>(n, p) Ru<sup>103</sup> + Rh<sup>103</sup>(n, pn + n, np + n, d) Ru<sup>102</sup>

45-103g1 diff.	V57	—	14	$4\pi \left[ \frac{d\sigma}{d\Omega} \right] = 15 \pm 4$ ; means for $\theta = 30^\circ, 45^\circ, 60^\circ, 90^\circ, 120^\circ, 135^\circ, 150^\circ$ and $E_p > 7$ MeV	cf. 12-gI			
45-103g2 diff.	E59 II	—	14	$\frac{\sigma}{\text{Sterad.}} = 4.8 \pm 0.5$ for $d\Omega = 0^\circ - 15^\circ$ and $E_p > 4$ MeV	cf. 51-gI	Foil, thickness 30-40 mg/cm <sup>2</sup>		

### Rh<sup>103</sup>(n, $\alpha$ ) Te<sup>100</sup>

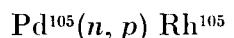
45-103i1	P53	80 sec	14.5 ± 0.35	63 ± 25	cf. 7-14a1	Rh <sub>2</sub> O <sub>3</sub>
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\* Also measured for  $10.3 \text{ MeV} \leq E_n \leq 15.1 \text{ MeV}$

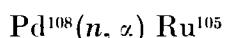
## P A L L A D I U M



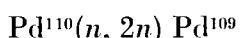
46-104 <i>b1g+m</i>	P53	<i>44 sec for Rh<sup>104g</sup></i> <i>4.3 min for Rh<sup>104m</sup></i>	$14.5 \pm 0.35$	$132 \pm 66$		<i>cf. 7-14<i>a1</i></i>	<i>Element</i>
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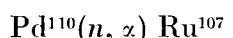
46-105 <i>b1</i>	P53	<i>36.5<i>h</i></i>	$14.5 \pm 0.35$	$743 \pm 520$		<i>cf. 7-14<i>a1</i></i>	<i>Element</i>
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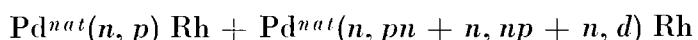
46-108 <i>i1</i>	B58	<i>4.5<i>h</i></i>	$14.05 \pm 0.55$	$2.3 \pm 0.4$		<i>cf. 27-59<i>i3</i></i>	
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46-110 <i>a1</i>	P53	<i>13<i>h</i></i>	$14.5 \pm 0.35$	$1948 \pm 1000$		<i>cf. 7-14<i>a1</i></i>	<i>Element</i>
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46-110 <i>i1</i>	P53	<i>4 min</i>	$14.5 \pm 0.35$	$13.8 \pm 6.2$		<i>cf. 7-14<i>a1</i></i>	<i>Element</i>
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46- <i>g1</i> diff.	V57	<i>—</i>	<i>14</i>	$4\pi \left[ \frac{d\sigma}{d\theta} \right] = 7 \pm 2$		<i>cf. 12-<i>g1</i></i>	
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means for  $\theta = 30^\circ$ ,  
 $45^\circ$ ,  $60^\circ$ ,  $90^\circ$ ,  $120^\circ$ ,  
 $135^\circ$ ,  $150^\circ$  and  $E_p >$   
 $8 \text{ MeV}$

## S I L V E R

 $\text{Ag}^{107}(n, 2n) \text{ Ag}^{106}$  I 24.5 min.

47-107a1 I	P53	25 min	$14.5 \pm 0.35$	$519 \pm 260$		cf. 7-14a1	Element
47-107a2 I	F53	24.5 min	14.1	$560 \pm 56$		cf. 13-27b2	
47-107a3 I	Y57	24.3 min	$14.1 \pm 0.15$	$458 \pm 50$		cf. 13-27b3	
47-107a4 I	V61	24 min	14.1	$740 \pm 80$	rel. : cf. 13-27i10 $\text{Al}^{27}(n, \alpha) = 116 \text{ mb}$	$\beta$ -activity, $4\pi$ geometry, prop. counter	Total error Foil, 20 mg/cm <sup>2</sup> thick- ness
47-107a5 I	M61 II	24 min	14.8	$662 \pm 66$		cf. 11-23i2	
47-107a6 I	R61 II	$24.4 \pm 0.5$ min* <sup>1</sup>	$14.4 \pm 0.3$	$889 \pm 65$		cf. 7-14a7	Element
47-107a7 I	S61 II	24.5 min	$14.1 \pm 0.2$	$537 \pm 15$		cf. 13-27b12	
47-107a8 I	K61 II	24.2 min	$14.8 \pm 0.5$	$657 \pm 100$		cf. 17-35a5m	
47-107a9 I	T60	—	13.9* <sup>2</sup>	325	—	—	—
			14.0	340			
			14.6	360			
			15.1	390			

 $\text{Ag}^{107}(n, 2n) \text{ Ag}^{106}$  II 8d

47-107a1 II	V61	8.4d	14.1	$600 \pm 78$	rel. : cf. 13-27i10 $\text{Al}^{27}(n, \alpha) = 116 \text{ mb}$	K- $\gamma$ -coincidence with 2 NaI crystals	Total error	Foil, 0.3 mg/cm <sup>2</sup> thickness
47-107a2 II	M61 II	8.2d	14.8	~6500		cf. 11-23i2		
47-107a3 II	P61 IV		Rel. measurement* <sup>3</sup>			cf. 22-46a2		

<sup>\*1</sup> Measured by the authors<sup>\*2</sup> Also measured for  $10.3 \text{ MeV} \leq E_n \leq 15.1 \text{ MeV}$ <sup>\*3</sup> Measured for  $9.5 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Ag}^{107}(n, n\gamma) \text{ Rh}^{103m}$								
47-107 <i>k1m</i>	B62 II	54 min	14.7	< 2.0	—	—	—	—
$\text{Ag}^{109}(n, 2n) \text{ Ag}^{108}$								
47-109 <i>a1</i>	P53	2.3 min	14.5 ± 0.35	311 ± 150	cf. 7-14 <i>a1</i>	Element		
47-109 <i>a2</i>	F52	2.3 min	14.1	1000 ± 100	cf. 13-27 <i>b2</i>			
47-109 <i>a3</i>	Y57	2.35 min	14.1 ± 0.15	604 ± 66	cf. 13-27 <i>b3</i>			
47-109 <i>a4</i>	V61	2.4 min	14.1	840 ± 150	rel.: cf. 47-107 <i>a4</i> I $\text{Ag}^{107}(n, 2n) = 740 \text{ mb}$	$\beta$ -activity, $2\pi$ geometry, Total error prop. counter	Foil 20 mg/cm <sup>2</sup>	thickness
47-109 <i>a5</i>	K59 II	2.3 min	14.3 ± 0.5	619 ± 110	cf. 13-27 <i>b7</i>			
47-109 <i>a6</i>	M61 II	—	14.8	883 ± 88	cf. 24-50 <i>a2</i>			
47-109 <i>a7</i>	R59 I	2.3 min	14.8 ± 0.5	710 ± 110	cf. 17-35 <i>a3m</i>			
$\text{Ag}^{109}(n, p) \text{ Pd}^{109}$								
47-109 <i>b1</i>	C59 II	—	14.5	12.5 ± 1.9	cf. 49-115 <i>i2</i>			
47-109 <i>b2</i>	D58	14 <i>h</i>	14	10.5 ± 1.8	cf. 48-112 <i>i2</i>			
47-109 <i>b3</i>	P61 IV	—	14.31 ± 0.13*	14.3 ± 1.7	cf. 22-46 <i>a2</i>			
			14.50 ± 0.20	14.9 ± 1.8				
			14.68 ± 0.26	14.9 ± 1.8				
			14.81 ± 0.31	14.8 ± 1.8				
			14.93 ± 0.31	14.7 ± 1.8				
47-109 <i>b4</i>	M61 II	—	14.8	2.7 ± 0.5	cf. 11-23 <i>i2</i>			
$\text{Ag}^{109}(n, \gamma) \text{ Rh}^{106}$								
47-109 <i>i1</i>	K59 II	140.8 min	14.3 ± 0.55	38 ± 6	cf. 13-27 <i>b7</i>			

\* Also measured for 7 MeV ≤ E<sub>n</sub> ≤ 19.8 MeV

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Ag}^{109}(n, n\alpha) \text{ Rh}^{105g}$								
47-109k1g	B62 II	36h	14.7	$< 0.60$	—	—	—	—
$\text{Ag}^{nat}(n, 2n) \text{ Ag}$								
47-a1	A58 II	—	14.1	$1730 \pm 130$	cf. 1-2a1			Element
$\text{Ag}^{nat}(n, p + n, pn) \text{ Pd}$								
47-d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} < 14$	cf. 11-23d1			
47-d2 diff.	C59 I	—	14.5	$4\pi \left[ \frac{d\sigma}{d\Omega} \right] = 28 \pm 3$ means for $\theta = 0^\circ, 45^\circ, 90^\circ, 135^\circ$ and $d\Omega = 18^\circ$	cf. 29-d2			
$\text{Ag}^{nat}(n, p + n, pn + n, np + n, d) \text{ Pd}$								
47-g1 diff.	E59 I	—	14	$\frac{\sigma}{\text{Sterad.}} = 3.5 \pm 0.7$ for $d\Omega = 0^\circ - 15^\circ$ and $E_p > 4 \text{ MeV}$	cf. 51-g1		Foil, 40-50 mg/cm <sup>2</sup> thickness	



### C A D M I U M

#### $\text{Cd}^{106}(n, 2n) \text{ Cd}^{105}$

48-106a1	R61 II	$50.7 \pm 1.0$ min* <sup>1</sup>	$14.4 \pm 0.3$	$827 \pm 63$		cf. 7-14a7		Element
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#### $\text{Cd}^{106}(n, p) \text{ Ag}^{106}$

48-106b1	L58	24 min	14	$76 \pm 24$	rel. : cf. 48-112i2 $\text{Cd}^{112}(n, \alpha) = 1.35$ mb	$\beta$ -activity, geiger counter, chem. separation	—	—
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#### $\text{Cd}^{111}(n, p) \text{ Ag}^{111}$

48-111b1	L58	—	14	$15 \pm 4$		cf. 48-106b1	
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48-111b2	P61 IV	—	$14.01 \pm 0.10$ * <sup>2</sup>	$23.5 \pm 1.4$		cf. 22-46a2	
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$14.09 \pm 0.10$   
 $14.31 \pm 0.13$   
 $14.50 \pm 0.20$   
 $14.81 \pm 0.31$   
 $14.93 \pm 0.36$

#### $\text{Cd}^{112}(n, p) \text{ Ag}^{112}$

48-112b1	L58	—	14	$9.8 \pm 3$		cf. 48-106b1	
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#### $\text{Cd}^{112}(n, \alpha) \text{ Pd}^{109}$

48-112i1	P61 IV	—	$13.88 \pm 0.10$ * <sup>3</sup>	$2.3 \pm 0.1$		cf. 22-46a2	
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$14.09 \pm 0.10$   
 $14.31 \pm 0.13$   
 $14.50 \pm 0.20$   
 $14.68 \pm 0.26$   
 $14.81 \pm 0.31$   
 $14.93 \pm 0.36$

\*<sup>1</sup> Measured by the authors

\*<sup>2</sup> Also measured for  $7 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

\*<sup>3</sup> Also measured for  $7 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
48-112 <i>i2</i>	D58	14 <i>h</i>	14.1	1.35 ± 0.27	rel. : cf. 27-63 <i>a</i> Cu <sup>63</sup> ( <i>n</i> , 2 <i>n</i> ) = 500 mb	β-activity, geiger-counter ; chemical separation. Cor- rections for absolute β- counting exp. determi- nated with standard sour- ces and Al-foils of diffe- rent thickness	Standard deviation	Thickness after chem. separation 2 mg/cm <sup>2</sup>
					Cd <sup>113</sup> ( <i>n</i> , <i>p</i> ) Ag <sup>113</sup>			
48-113 <i>b1</i>	L58	—	14	7.2 ± 2.2		cf. 48-106 <i>b1</i>		
					Cd <sup>114</sup> ( <i>n</i> , <i>α</i> ) Pd <sup>111</sup> <i>g</i>			
48-114 <i>ig</i>	D58	22 min	14.1	0.51 ± 0.13		cf. 48-112 <i>i2</i>		
					Cd <sup>114</sup> ( <i>n</i> , <i>α</i> ) Pd <sup>111</sup> <i>m</i>			
48-114 <i>i1m</i>	D58	5.5 <i>h</i>	14.1	0.13 ± 0.06		cf. 48-112 <i>i2</i>		
					Cd <sup>116</sup> ( <i>n</i> , 2 <i>n</i> ) Cd <sup>115</sup> - tot.			
48-116 <i>a1t</i>	P61 I	—	14.01 ± 0.10*	1690 ± 118		cf. 22-46 <i>a2</i>		
			14.09 ± 0.10	1604 ± 115				
			14.31 ± 0.13	1748 ± 124				
			14.50 ± 0.20	1634 ± 116				
			14.68 ± 0.26	1642 ± 117				
			14.81 ± 0.31	1588 ± 113				
			14.93 ± 0.36	1634 ± 116				
					Cd <sup>116</sup> ( <i>n</i> , 2 <i>n</i> ) Cd <sup>115</sup> <i>g</i>			
48-116 <i>a1g</i>	K61 II	53.5 <i>h</i>	14.8 ± 0.5	690 ± 100		cf. 17-35 <i>a5m</i>		

\* Also measured for 8.8 MeV ≤ E<sub>n</sub> ≤ 19.8 MeV

I	II	III	IV	V	VI	VII	VIII	IX
48-116a2g	P61 I	53h	14.01 $\pm$ 0.10*	850 $\pm$ 85		cf. 22-46a2		
			14.09 $\pm$ 0.10	835 $\pm$ 84				
			14.31 $\pm$ 0.13	863 $\pm$ 86				
			14.50 $\pm$ 0.20	826 $\pm$ 83				
			14.68 $\pm$ 0.26	817 $\pm$ 82				
			14.81 $\pm$ 0.31	781 $\pm$ 78				
			14.93 $\pm$ 0.36	798 $\pm$ 80				
					Cd <sup>116</sup> (n, 2n) Cd <sup>115m</sup>			
48-116a1m	P61 I	43d	14.01 $\pm$ 0.10*	840 $\pm$ 84		cf. 22-46a2		
			14.09 $\pm$ 0.10	769 $\pm$ 77				
			14.31 $\pm$ 0.13	855 $\pm$ 86				
			14.50 $\pm$ 0.20	808 $\pm$ 81				
			14.68 $\pm$ 0.26	825 $\pm$ 83				
			14.81 $\pm$ 0.31	807 $\pm$ 81				
			14.93 $\pm$ 0.36	836 $\pm$ 84				
48-116a2m	K61 II	43.5d	14.8 $\pm$ 0.5	490 $\pm$ 70		cf. 17-35a5m		
					Cd <sup>nat</sup> (n, 2n) Cd			
48-a1	A58 II	—	14.1	1920 $\pm$ 150		cf. 1-2a1		
					Cd <sup>nat</sup> (n, p) Ag + Cd <sup>nat</sup> (n, pn) Ag			
48-d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} < 14$		cf. 11-23d1		
					Cd <sup>nat</sup> (n, p + n, pn + n, np + n, d) Ag			
48-g1 diff.	E59 II	—	14	$\frac{\sigma}{\text{Sterad.}} = 3.8 \pm 0.4$ for $d\Omega = 0^\circ - 15^\circ$ and $E_p > 5 \text{ MeV}$		cf. 51-g1		Foil, 30-40 mg/cm <sup>2</sup> thickness

\* Also measured for 12 MeV  $\leq E_n \leq$  19.8 MeV



## I N D I U M

### $\text{In}^{115}(n, 2n) \text{ In}^{114m}$ I 42 msec.

49-115a1m I	G59 I	$42 \pm 2$ msec <sup>*1</sup>	14.5	$800 \pm 400$	rel. : cf. 29-63a $\text{Cu}^{63}(n, 2n) = 500$ mb	cf. 12-24b1m
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### $\text{In}^{115}(n, 2n) \text{ In}^{114m}$ II 50d

49-115a2m II	P61 I	50.0d	$13.88 \pm 0.10^{*2}$	$1523 \pm 76$		cf. 22-46a2
			$14.01 \pm 0.10$	$1557 \pm 78$		
			$14.31 \pm 0.13$	$1500 \pm 77$		
			$14.50 \pm 0.20$	$1539 \pm 77$		
			$14.81 \pm 0.31$	$1585 \pm 79$		
			$14.93 \pm 0.36$	$1503 \pm 76$		

### $\text{In}^{115}(n, p) \text{ Cd}^{115}$

49-115b1	D58	—	14.5	$15.5 \pm 4$		cf. 48-112i2
49-115b2	P61 VI	—	14	$20 \pm 9$	—	—

### $\text{In}^{115}(n, \alpha) \text{ Ag}^{112}$

49-115i1	B55 III	3.2h	$14.05 \pm 0.55$	$2.5 \pm 0.4$		cf. 27-59i3
49-115i2	C59 II	—	14.5	$2.89 \pm 0.29$	rel. : $\text{Al}^{27}(n, \alpha) = ?$	$\beta$ -activity, $4\pi$ geometry prop. counter. Activity measured after chem. separation with a foil of 20 $\mu\text{g}/\text{cm}^2$ . Absorption and scattering of the $\beta$ in the foil neglected

<sup>\*1</sup> Measured by the authors

<sup>\*2</sup> Also measured for  $9.3 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
					$\text{In}^{115}(n, n\alpha) \text{Ag}^{111g}$			
49-115kl	B62 II	7.5d	14.7	< 0.055	—	—	—	—
					$\text{In}^{nat}(n, p + n, pn) \text{Cd}$			
49-d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} < 14$		cf. 11-23d1		
					$\text{In}^{nat}(n, p + n, pn + n, np + n, d) \text{Cd}$			
49-g1 diff.	E59 II	—	14	$\frac{\sigma}{\text{Sterad.}} = 1.6 \pm 0.3$ for $d\Omega = 0^\circ \text{-- } 15^\circ$ and $E_p > 4.5 \text{ MeV}$		cf. 51-g1		Foil. 30-40 mg/cm <sup>2</sup> thickness
49-92 diff.	V57	—	11	$4\pi \left[ \frac{d\sigma}{d\Omega} \right] = 20 \pm 9$ means for $0 = 30^\circ, 45^\circ, 60^\circ, 90^\circ, 120^\circ, 135^\circ, 150^\circ$ and $E_p > 8 \text{ MeV}$		cf. 12-g1		

I

II

III

IV

V

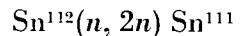
VI

VII

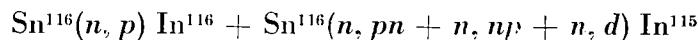
VIII

IX

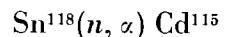
## TIN



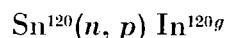
50-112 <i>a1</i>	R59 I	$32.5 \text{ min}$	14	$1400 \pm 110$		cf. 17-35 <i>a3m</i>		
50-112 <i>a2</i>	R61 II	$32.1 \pm 0.6 \text{ min}^{\ast 1}$	$14.4 \pm 0.3$	$1508 \pm 122$		cf. 7-14 <i>a7</i>		Element
50-112 <i>a3</i>	P61 I		Rel. measurement <sup><i>*2</i></sup>			cf. 22-46 <i>a2</i>		
50-112 <i>a4</i>	T60	—	$13.9^{\ast 3}$	$725 \pm 80$	—	—	—	—



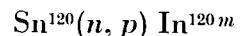
50-g1 diff.	E59 II	—	14	$\frac{\sigma}{\text{Sterad.}} < 1 \text{ for } d\Omega$ $= 0^\circ - 15^\circ \text{ and } E_p$ $> 4 \text{ MeV}$	cf. 51-g1	$\text{Sn}^{116}$ enriched 98 %: thickness 10 mg/cm <sup>2</sup>
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50-118 <i>i1</i>	P61 IV	53 <i>h</i>	$13.88 \pm 0.10^{\ast 4}$	$0.76 \pm 0.05$	cf. 22-46 <i>a2</i>	
			$14.09 \pm 0.10$	$0.93 \pm 0.07$		
			$14.31 \pm 0.13$	$0.94 \pm 0.07$		
			$14.50 \pm 0.20$	$1.14 \pm 0.08$		
			$14.68 \pm 0.26$	$1.13 \pm 0.08$		
			$14.81 \pm 0.31$	$1.23 \pm 0.09$		



50-120 <i>b1g</i>	P60 II	3 sec	$14.8 \pm 0.8$	$\sim 1$	cf. 27-59 <i>a1g</i>	$\text{Sn}^{120}$ enriched
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50-120 <i>b1m</i>	P60 II	50 sec	$14.8 \pm 0.8$	$2.8 \pm 1$	cf. 27-59 <i>lg</i>	$\text{Sn}^{120}$ enriched
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<sup>*\*1*</sup> Measured for the authors<sup>*\*2*</sup> Measured for  $11.2 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$ <sup>*\*3*</sup> Also measured for 11.8 MeV and 12.9 MeV<sup>*\*4*</sup> Also measured for  $12 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
50-I20gI diff.	E59 II	—	14	$\frac{\sigma}{\text{Sterad.}} < 1 \text{ for } d\Omega$ = $0^\circ - 15^\circ$ and $E_p$ $> 4 \text{ MeV}$		cf. 50-gI		$\text{Sn}^{12}\text{Y}^0$ enriched 98 %: thickness 10 mg/cm <sup>2</sup>
50-dI diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\theta} \right]_{120^\circ} < 15$		cf. 11-23dI		

## ANTIMONY

 $\text{Sb}^{121}(n, 2n) \text{ Sb}^{120}$  I 16 min.

51-121a1 I	P53	15 min	$14.5 \pm 0.35$	$750 \pm 150$	cf. 7-14a1	Element
51-121a2 I	R58 I	15.7 min	14	1000	cf. 7-14a2	
51-121a3 I	K59 III	16.2 min	$14.3 \pm 0.5$	$453 \pm 41$	cf. 13-27b7	
51-121a4 I	R61 II	$15.7 \pm 0.3$ min* <sup>1</sup>	$14.4 \pm 0.3$	$1056 \pm 80$	cf. 7-14a7	Element
51-121a5 I	K61 II	16.5 min	$14.8 \pm 0.5$	$1180 \pm 180$	cf. 17-35a5m	

 $\text{Sb}^{121}(n, 2n) \text{ Sb}^{120}$  II 5.8d

51-121a1 II	P61 I	Rel. measurement* <sup>2</sup>	cf. 22-46a2
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 $\text{Sb}^{123}(n, 2n) \text{ Sb}^{122g+m}$ 

51-123a1g+m	P53	2.8d	$14.5 \pm 0.35$	$1245 \pm 300$	cf. 7-14a1	Element
51-123a2g+m	K59 II	2.8d	$14.3 \pm 0.5$	$1706 \pm 100$	cf. 13-27b7	
51-123a3g+m	K61 II	2.8d	$14.8 \pm 0.5$	$1950 \pm 200$	cf. 17-35a5m	
51-123a4g+m	P61 IV	—	$14.00 \pm 0.10$ * <sup>3</sup>	$1280 \pm 70$	cf. 22-46a2	
			$14.09 \pm 0.10$	$1336 \pm 65$		
			$14.31 \pm 0.13$	$1263 \pm 60$		
			$14.50 \pm 0.20$	$1342 \pm 70$		
			$14.68 \pm 0.26$	$1255 \pm 65$		
			$14.81 \pm 0.31$	$1280 \pm 65$		
			$14.93 \pm 0.36$	$1192 \pm 60$		

<sup>1</sup> Measured by the authors<sup>2</sup> Measured for  $9.4 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$ <sup>3</sup> Also measured for  $12 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
<b>Sb<sup>nat</sup>(n, p + n, pn) Sn</b>								
51-d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} = 11 \pm 6$		cf. 11-23d1		
<b>Sb<sup>nat</sup>(n, p + n, pn + n, np + n, d) Sn</b>								
51-g1 diff.	P59 III	—	14	$\frac{d\sigma}{d\Omega} = 22 \pm 4$ for abs. : proton recoil-telescope $d\Omega = 0^\circ - 60^\circ$ and $E_p > 5$ MeV	Telescope ; 2 prop. counters in coincidence with a CsI crystal	Stat. error	Thickness 7 mg/cm <sup>2</sup>	
51-g2 diff.	E59 II	—	14	$\frac{\sigma}{\text{Sterad.}} = 40 \pm 2$ for $d\Omega = 0^\circ - 15^\circ$ and $E_p > 5$ MeV	cf. 50-g1		Thickness 30-40 mg/cm <sup>2</sup>	

## T E L L U R I U M

$$\text{Te}^{128}(n, 2n) \text{ Te}^{127}$$

I	II	III	IV	V	VI	VII	VIII	IX
52-128a1	P53	9.3 <i>h</i>		14.5 $\pm$ 0.35	< 779 $\pm$ 230		cf. 7-14a1	
$\text{Te}^{128}(n, pn) \text{ Sb}^{127} + \text{Te}^{128}(n, np + n, d) \text{ Sb}^{127}$								
52-128c1	B59 II	—	14.5	0.33 $\pm$ 0.05	rel. : cf. 13-27 <i>i</i> $\text{Al}^{27}(n, \alpha) = 111$ mb Sandwich method	Aetivation method, 4 $\pi$ counter; chemical separation. $\sigma(n, np)$ and $\sigma(n, d)$ are supposed to be small	—	Foils; 50 mg/cm <sup>2</sup> thickness. Isotopically enriched targets
$\text{Te}^{130}(n, 2n) \text{ Te}^{129g+m}$								
52-130a1g+m	P53	70 min, 32 <i>d</i>	14.5 $\pm$ 0.35	599 $\pm$ 120		cf. 7-14a1		
$\text{Te}^{130}(n, pn) \text{ Sb}^{129} + \text{Te}^{130}(n, np + n, d) \text{ Sb}^{129}$								
52-130c1	B59 II	—	14.5	0.17 $\pm$ 0.02		cf. 52-128e1		
$\text{Te}^{130}(n, \alpha) \text{ Sn}^{127}$								
52-130 i1	C59 II	—	14.5	0.37 $\pm$ 0.06		cf. 49-115 <i>i</i> 2		
$\text{Te}^{nat}(n, p + n, pn) \text{ Sb}$								
52-d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} < 5$		cf. 11-23 <i>d</i> 1		
$\text{Te}^{nat}(n, p + n, pn + n, np + n, d) \text{ Sb}$								
52-g1 diff.	E59 II	—	14	$\frac{\sigma}{\text{Sterad.}} < 1$ for $d\Omega$ = 0° — 15° and $E_p$ > 5 MeV		cf. 51-g1		Powder 40 mg/cm <sup>2</sup> thickness



## I O D I N E

### $I^{127}(n, 2n) I^{126}$

53-127a1	P53	$13d$	$14.5 \pm 0.35$	$1120 \pm 400$		cf. 7-14a1		$NH_4I$ ; ; $LiI$
53-127a2	M53	$13.1d$	$14.1^{*1}$	$1300 \pm 80$	abs. : Long-counter calibrated with a Ra-Be source	$\beta$ -activity; NaI crystal served as target and counter	Estimated total error	NaI crystal
53-127a3	B62 I	$13.05 \pm 0.08d^{*2}$	$14.1 \pm 0.1^{*3}$	$13.20 \pm 110$		cf. 29-65a8		$I_2O_5$

### $I^{127}(n, p) Te^{127}$

53-127b1	P53	$9.3h$	$14.5 \pm 0.35$	$< 231 \pm 140$		cf. 7-14a1		$NH_4I$ ; ; $LiI$
53-127b2	B60	$9h$	$14.1 \pm 0.1$	$25 \pm 15$		cf. 11-23b2		
53-127b3	D58	—	14.5	$11.7 \pm 1.8$		cf. 48-112i2		

### $I^{127}(n, p) Te^{127} + I^{127}(n, pn) Te^{126}$

53-127d1 diff.	A61	—	14.1	$4\pi \left[ \frac{d\sigma}{d\Omega} \right]_{120^\circ} = 5$		cf. 11-23d1		
53-127d2	B61 IV	—	$14.1 \pm 0.1^{*4}$	13.1 $\pm$ 1.3 by évaporation 2.1 $\pm$ 0.2 by direct-processes	rel. : cf. 3-6h5 $Li^6(n, \alpha) = 25.8$ mb and the assumption $\sigma_i^{127}(n, p) \approx \sigma_{es}^{133}(n, p)$	CsI crystal served as target and counter. Separation of $\alpha$ -, $p$ - and $\gamma$ -pulses by pulse shape discrimination. Separation of $n, p$ - and $n, np$ -processes and of evaporation- and direct-processes by stat. theory	Error contains : neutron flux; pulse shape discrimination; statistics.	CsI crystal

\*1 Also measured for  $9.5 \text{ MeV} \leq E_n \leq 18 \text{ MeV}$

\*2 Measured by the authors

\*3 Also measured for  $12.8 \text{ MeV} \leq E_n \leq 19.6 \text{ MeV}$

\*4 Also measured for  $13 \text{ MeV} \leq E_n \leq 21 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
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$I^{127}(n, np) Te^{126}$

53-127e1	B61 IV	—	$14.1 \pm 0.1^{*1}$	$1.3 \pm 0.2$	rel. : cf. 3-6h5 $Li^6(n, \alpha) = 25.8$ mb and the assumption $\sigma_{i^{127}}(n, np) \approx \sigma_{cs^{133}}(n, np)$	cf. 53-127d2
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$I^{127}(n, \alpha) Sb^{124}$

53-127i1	P53	20 min	$14.5 \pm 0.35$	$< 18.4 \pm 2.8$	cf. 7-14a1	$NH_4I ; LiI$
53-127i2	B61 IV	—	$14.1 \pm 0.1^*$	$1.08 \pm 0.13$	cf. 53-127d2 and for $p$ - say $\alpha$	

$I^{127}(n, n\alpha) Sb^{123}$

53-127k1	B61 IV	—	$14.1 \pm 0.1^*$	$0.02 \pm 0.004$	cf. 53-127e1 and for $p$ say $\alpha$
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\*1 Also measured for  $13 \text{ MeV} \leq E_n \leq 21 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
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## C E S I U M

$\text{Cs}^{133}(n, 2n) \text{ Cs}^{132}$

55-133 <i>a1</i>	M61 I	—	14.1	$1550 \pm 250$		cf. 38-86 <i>alm</i>		$\text{Cs}_2\text{CO}_3$ powder
55-133 <i>a2</i>	B62 I	$6.44 \pm 0.05^{*1}$	$14.1 \pm 0.1^{*2}$	$1289 \pm 130$		cf. 29-65 <i>a8</i>		$\text{Cs}_2\text{CO}_3$

$\text{Cs}^{133}(n, p) \text{ Xe}^{133} + \text{Cs}^{133}(n, pn) \text{ Xe}^{132}$

55-133 <i>d1</i>	B61 IV	—	$14.1 \pm 0.1^{*3}$	$13.1 \pm 1.3$ by evaporation $2.1 \pm 0.2$ by direct processes		cf. 53-127 <i>d2</i>		
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$\text{Cs}^{133}(n, np) \text{ Xe}^{132}$

55-133 <i>e1</i>	B61 IV	—	$14.1 \pm 0.1^{*3}$	$1.3 \pm 0.2$		cf. 52-127 <i>e1</i>		
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$\text{Cs}^{133}(n, \text{He}^3) \text{ I}^{131}$

55-133 <i>f1</i>	B62 II	8.1 <i>d</i>	14.7	$< 0.15$	—	—	—	—
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$\text{Cs}^{133}(n, 2p) \text{ I}^{132}$

55-133 <i>h1</i>	B62 II	2.3 <i>h</i>	14.7	$< 0.005$	—	—	—	—
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$\text{Cs}^{133}(n, \alpha) \text{ I}^{130}$

55-133 <i>i1</i>	B58	12.6 <i>h</i>	$14.05 \pm 0.05$	$1 \pm 0.3$		cf. 27-59 <i>i3</i>		
55-133 <i>i2</i>	C59 II	—	14.5	$1.9 \pm 0.2$		cf. 49-115 <i>i2</i>		
55-133 <i>i3</i>	B61 IV	—	$14.1 \pm 0.1^{*3}$	$1.08 \pm 0.13$		cf. 53-127 <i>i2</i>		

\*1 Measured by the authors

\*2 Also measured for  $13 \text{ MeV} \leq E_n \leq 19.6 \text{ MeV}$

\*3 Also measured for  $13 \text{ MeV} \leq E_n \leq 21 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
55-133k1	B61 1V	—	14.1 $\pm$ 0.1*	0.02 $\pm$ 0.004	Cs <sup>133</sup> (n, n $\alpha$ ) I <sup>129</sup>	cf. 53-127k1		

\* Also measured for 13 MeV  $\leq E_n \leq$  21 MeV

## B A R I U M

### $\text{Ba}^{134}(n, 2n) \text{ Ba}^{133m}$

56-134alm	W60 I	$38.9 \pm 0.1h^*$	$14.8 \pm 0.8$	$940 \pm 80$	cf. 13-27b4	$\text{BaO}_2$ ; $\text{BaCl}_2 \cdot 2\text{HO}$ $\text{Ba}(\text{NO}_3)_2$ ; thickness 30-150 mg/cm <sup>2</sup>
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### $\text{Ba}^{136}(n, 2n) \text{ Ba}^{135m}$

56-136alm	W60 I	$28.7 \pm 0.2h^*$	$14.8 \pm 0.8$	$700 \pm 80$	cf. 13-27b4	cf. 56-134alm
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### $\text{Ba}^{136}(n, p) \text{ Cs}^{136}$

56-136b1	W60 I	$13.5 \pm 0.5d^*$	$14.8 \pm 0.8$	$49 \pm 10$	cf. 13-27b4	cf. 56-134alm
56-136b2	C59 II	—	14.5	$38.3 \pm 4$	cf. 49-115i2	

### $\text{Ba}^{138}(n, 2n) \text{ Ba}^{137m}$

56-138alm	W60 I	$2.6 \pm 0.1 \text{ min}^*$	$14.8 \pm 0.8$	$1250 \pm 100$	cf. 13-27b4	cf. 56-134alm
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### $\text{Ba}^{138}(n, p) \text{ Cs}^{138}$

56-138b1	P53	33 min	$14.5 \pm 0.35$	$6.3 \pm 2.2$	cf. 7-14a1	$\text{BaCO}_3$
56-138b2	W60 I	$32.5 \pm 0.5 \text{ min}^*$	$14.8 \pm 0.8$	$2.5 \pm 1.2$	cf. 13-27b4	
56-138b3	C59 II	—	14.5	$2.2 \pm 0.3$	cf. 49-115i2	

### $\text{Ba}^{138}(n, \alpha) \text{ Xe}^{135g}$

56-138i1g	F61 II	—	$14.2 \pm 0.2$	$13 \pm 2$	cf. 13-27b11	
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### $\text{Ba}^{138}(n, \alpha) \text{ Xe}^{135m}$

56-138i1m	F61 II	—	$14.1 \pm 0.2$	$13 \pm 2$	cf. 13-27b11	
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\* Measured by the authors

## L A N T H A N U M

### $\text{La}^{139}(n, p) \text{Ba}^{139}$

57-139 <i>b1</i>	P53	85 min	$14.5 \pm 0.35$	$5.7 \pm 2.4$		cf. 7-14 <i>a1</i>		$\text{La}(\text{NO}_3)_3$
57-139 <i>b2</i>	W60 I	$85 \pm 1$ min*	$14.8 \pm 0.8$	$5 \pm 1$		cf. 13-27 <i>b4</i>		$\text{La}_2\text{O}_3$ ; $\text{La}(\text{NO}_3)_3$ . $\text{CH}_2\text{O}$ ; thickness 35- 180 mg/cm <sup>2</sup>
57-139 <i>b3</i>	C59 II	—	14.5	$2.33 \pm 0.35$		cf. 49-115 <i>i2</i>		—

### $\text{La}^{139}(n, 2p) \text{Cs}^{138}$

57-139 <i>h1</i>	B62 II	32 min	14.7	$< 0.032$	—	—	—	—
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### $\text{La}^{139}(n, \alpha) \text{Cs}^{136}$

57-139 <i>i1</i>	W60 I	$13.5 \pm 1.5d^*$	$14.8 \pm 0.8$	1.3		cf. 13-27 <i>b4</i>		cf. 57-139 <i>b2</i>
57-139 <i>i2</i>	C59 II	—	14.5	$187 \pm 20$		cf. 49-115 <i>i2</i>		—

\* Measured by the authors

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## C E R I U M

$\text{Ce}^{140}(n, 2n) \text{ Ce}^{139 \text{ tot.}}$

58-140a1t	W60 I	—	$14.8 \pm 0.8$	$3000 \pm 400$		cf. 27-59a1g	cf. 58-140a1m
					$\text{Ce}^{140}(n, 2n) \text{ Ce}^{139g}$		
58-140a1g	W60 I	$140 \pm 10d^*$	$14.8 \pm 0.8$	$1800 \pm 400$		cf. 27-59a1g	cf. 58-140a1m
					$\text{Ce}^{140}(n, 2n) \text{ Ce}^{139m}$		
58-140a1m	W60 I	$65 \pm 10 \text{ sec}^*$	$14.8 \pm 0.8$	$1200 \pm 400$		cf. 27-59a1g	Ce(NO <sub>3</sub> ) <sub>3</sub> .6H <sub>2</sub> O ; thickness 30-120 mg/ cm <sup>2</sup>
58-140a2m	P61 III	$57 \pm 5 \text{ sec}^*$	$14.1 \pm 0.1$	$1440 \pm 160$		cf. 13-27b8	
					$\text{Ce}^{140}(n, p) \text{ La}^{140}$		
58-140b1	W60 I	$40 \pm 2h^*$	$14.8 \pm 0.8$	$10 \pm 2$		cf. 27-59a1g	cf. 58-140a1m
58-140b2	C59 II	—	14.5	$12.1 \pm 1.2$		cf. 49-115i2	
					$\text{Ce}^{140}(n, \alpha) \text{ Ba}^{137m}$		
58-140i1m	P53	2.5 min	$14.5 \pm 0.35$	$12.1 \pm 6$		cf. 7-14a1	Ce(NO <sub>3</sub> ) <sub>3</sub>
58-140i2m	W60 I	$2.6 \pm 0.1 \text{ min}^*$	$14.8 \pm 0.8$	$9 \pm 2$		cf. 27-59a1g	cf. 58-104a1m
					$\text{Ce}^{142}(n, 2n) \text{ Ce}^{141}$		
58-142a1	W60 I	$32 \pm 2d^*$	$14.8 \pm 0.8$	$1600 \pm 300$		cf. 27-59a1g	cf. 58-140a1m

\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Ce}^{142}(n, p) \text{ La}^{141}$								
58-142b1	W60 I	77 $\pm$ 3 min*	14.8 $\pm$ 0.8	5 $\pm$ 2		cf. 27-59a1g		cf. 58-140a1m
58-142b2	C59 II	—	14.5	9.4 $\pm$ 0.9		cf. 49-115i2		
$\text{Ce}^{142}(n, pn) \text{ La}^{141} + \text{Ce}^{142}(n, np + n, d) \text{ La}^{141}$								
58-142c1	B59 II	—	14.5	1.0 $\pm$ 0.2		cf. 52-128e1		
$\text{Ce}^{142}(n, z) \text{ Ba}^{139}$								
58-142i1	W60 I	85 $\pm$ 1 min*	14.8 $\pm$ 0.8	8 $\pm$ 2		cf. 27-59a1g		cf. 58-140a1m
58-142i2	C59 II	—	14.5	7.04 $\pm$ 0.7		cf. 49-115i2		

\* Measured by the authors

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## P R A S E O D Y N I U M

### $\Pr^{141}(n, 2n) \Pr^{140}$

59-141a1	P53	$3.4 \pm \text{min}$	$14.5 \pm 0.35$	$2060 \pm 700$		cf. 7-14a1	$\Pr\text{O}_2$
59-141a2	W60 I	$3.5 \pm 0.2 \text{ min}^{*1}$	$14.8 \pm 0.8$	$2100 \pm 300$		cf. 13-27b4	Element, $\Pr\text{O}_2$ $\Pr(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$ thickness 20-130 mg/ cm <sup>2</sup>
59-141a3	R58 I	$3.27 \pm \text{min}$	14	1768		cf. 7-14a2	
59-141a4	F60	—	$13.77 \pm 0.20^{*2}$ $14.74 \pm 0.27$	$1386 \pm 125$ $1591 \pm 143$		cf. 7-14a3	$\Pr\text{O}_2$
59-141a5	R61 II	$3.13 \pm 0.09 \text{ min}^{*1}$	$14.4 \pm 0.3$	$1801 \pm 135$		cf. 7-14a7	$\Pr_6\text{O}_{11}$
59-141a6	K61 II	$3.5 \pm \text{min}$	$14.8 \pm 0.5$	$1378 \pm 206$		cf. 17-35a5m	

### $\Pr^{141}(n, p) \text{Ce}^{141}$

59-141b1	W60 I	$32 \pm 2d^{*1}$	$14.8 \pm 0.8$	$4.5 \pm 1.0$		cf. 13-27b4	cf. 59-141a2
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### $\Pr^{141}(n, 2p) \text{La}^{140}$

59-141h1	B62 II	$40.2h$	14.7	$< 0.84$	—	—	—
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\*1 Measured by the authors

\*2 Also measured for  $12.5 \text{ MeV} \leq E_n \leq 18 \text{ MeV}$



## N E O D Y M I U M

### $\text{Nd}^{142}(n, 2n) \text{ Nd}^{141}$

60-142a1	W60 I	$2.5 \pm 0.3h^*$	$14.8 \pm 0.8$	$2060 \pm 200$		cf. 27-59a1g	$\text{Nd}_2\text{O}_3$ nat. and iso-top. enriched $\text{Nd}^{148}$ (84.59 %); $\text{Nd}^{150}$ (93.5 %)
60-142a2	R59 I	$2.53h$	14	$2480 \pm 200$		cf. 17-35a3m	
60-142a3	R61 II	$2.54 \pm 0.05h^*$	$14.4 \pm 0.3$	$2411 \pm 200$		cf. 7-14a7	$\text{Nd}_2\text{O}_3$

### $\text{Nd}^{142}(n, p) \text{ Pr}^{142}$

60-142b1	C59 II	—	14.5	$13.5 \pm 2.7$		cf. 19-115i2
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### $\text{Nd}^{142}(n, \alpha) \text{ Ce}^{139g}$

60-142i1g	W60 I	$140 \pm 10d^*$	$14.8 \pm 0.8$	$2 \pm 1$		cf. 27-59a1g	cf. 60-142a1
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### $\text{Nd}^{142}(n, \alpha) \text{ Ce}^{139m}$

60-142i1m	W60 I	$65 \pm 10 \text{ sec}^*$	$14.8 \pm 0.8$	$10 \pm 2$		cf. 27-59a1g	cf. 60-142a1
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### $\text{Nd}^{143}(n, p) \text{ Pr}^{143}$

60-143b1	C59 II	—	14.5	$11.5 \pm 2.3$		cf. 49-115i2
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### $\text{Nd}^{146}(n, \alpha) \text{ Ce}^{143}$

60-146i1	W60 I	$34 \pm 2h^*$	$14.8 \pm 0.8$	$8.3 \pm 2$		cf. 27-59a1g	cf. 60-142a1
60-146i2	C59 II	—	14.5	$2.6 \pm 0.4$		cf. 49-115i2	

\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
$\text{Nd}^{148}(n, 2n) \text{ Nd}^{147}$								
60-148a1	W60 I	$11.5 \pm 0.5d^*$	$14.8 \pm 0.8$	$2160 \pm 200$		cf. 27-59a1g		cf. 60-142a1
$\text{Nd}^{148}(n, p) \text{ Pr}^{148}$								
60-148b1	W60 I	$12 \pm 3 \text{ min}^*$	$14.8 \pm 0.8$	$3.5 \pm 0.8$		cf. 27-59a1g		cf. 60-142a1
$\text{Nd}^{148}(n, z) \text{ Ce}^{145}$								
60-148i1	W60 I	$3.1 \pm 0.2 \text{ min}^*$	$14.8 \pm 0.8$	$5 \pm 1$		cf. 27-59a1g		cf. 60-142a1
$\text{Nd}^{150}(n, 2n) \text{ Nd}^{149}$								
60-150a1	W60 I	$1.8 \pm 0.1h^*$	$14.8 \pm 0.8$	$2200 \pm 300$		cf. 27-59a1g		cf. 60-142a1

\* Measured by the authors

I	II	III	IV	V	VI	VII	VIII	IX
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## S A M A R I U M

### $\text{Sm}^{144}(n, 2n) \text{ Sm}^{143}$

62-144a1	W58	$8.5 \pm 0.3$ min*	$14.8 \pm 0.9$	$1200 \pm 300$		cf. 13-27b4	$\text{Sm}_2\text{O}_3$ nat. and enriched; $\text{Sm}^{154}$ : 97.2 %; $\text{Sm}^{152}$ : 99.7 %; thickness 35-120 mg/cm <sup>2</sup>
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62-144a2	R61 II	$9.4 \pm 0.6$ min*	$14.4 \pm 0.3$	$1484 \pm 120$		cf. 7-14a7	$\text{Sm}_2\text{O}_3$
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### $\text{Sm}^{152}(n, p) \text{ Pm}^{152}$

62-152b1	W58	$6.5 \pm 0.5$ min*	$14.8 \pm 0.9$	$3.7 \pm 0.2$		cf. 13-27b4	cf. 62-144a1
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### $\text{Sm}^{152}(n, z) \text{ Nd}^{149}$

62-152i1	P53	1.7h	$14.5 \pm 0.35$	$8.9 \pm 5$		cf. 7-14a1	$\text{Sm}_2\text{O}_3$
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62-152i2	W58	$1.6 \pm 0.3h^*$	$14.8 \pm 0.9$	$10 \pm 2$		cf. 13-27b4	cf. 62-144a1
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### $\text{Sm}^{154}(n, 2n) \text{ Sm}^{153}$

62-154a1	P53	47h	$14.5 \pm 0.35$	$< 2250 \pm 900$		cf. 7-14a1	$\text{Sm}_2\text{O}_3$
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62-154a2	W58	$45 \pm 3h^*$	$14.8 \pm 0.9$	$1500 \pm 300$		cf. 13-27b4	cf. 62-144a1
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### $\text{Sm}^{154}(n, p) \text{ Pm}^{154}$

62-154b1	W58	$2.5 \pm 0.5$ min*	$14.8 \pm 0.9$	$3.5 \pm 0.2$		cf. 13-27b4	cf. 62-144a1
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### $\text{Sm}^{154}(n, z) \text{ Nd}^{151}$

62-154i1	W58	$17.3 \pm 0.5$ min*	$14.8 \pm 0.9$	$9 \pm 3$		cf. 13-27b4	cf. 62-144a1
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\* Measured by the authors

## E U R O P I U M

### $\text{Eu}^{151}(n, 2n) \text{ Eu}^{150g}$

63-151a1g	W60 I	$15 \pm 1h^*$	$14.8 \pm 0.8$	$500 \pm 200$		cf. 13-27b4		
63-151a2g	K61 II	$13.4h$	$14.8 \pm 0.5$	$640 \pm 64$		cf. 17-35a5m		$\text{Eu}_2\text{O}_3$ thickness 23 mg/cm <sup>2</sup>

### $\text{Eu}^{153}(n, 2n) \text{ Eu}^{152m}$

63-153a1m	W60 I	$9.3 \pm 0.5h^*$	$14.8 \pm 0.8$	$750 \pm 200$		cf. 13-27b4		cf. 63-151a1g
63-153a2m	K61 II	$9.3h$	$14.8 \pm 0.5$	$164 \pm 25$		cf. 17-35a5m		

### $\text{Eu}^{153}(n, p) \text{ Sm}^{153}$

63-153b1	C59 II	—	14.5	$7.4 \pm 0.7$		cf. 49-115i2		
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\* Measured by the authors

## G A D O L I N I U M

$\text{Gd}^{156}(n, \alpha) \text{ Sm}^{153}$

64-156 <i>i1</i>	C59 II	—	14.5	$3.22 \pm 0.48$	cf. 49-115 <i>i2</i>
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$\text{Gd}^{157}(n, p) \text{ Eu}^{157}$

64-157 <i>b1</i>	C59 II	—	14.5	$11.3 \pm 1.7$	cf. 49-115 <i>i2</i>
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$\text{Gd}^{160}(n, 2n) \text{ Gd}^{159}$

64-160 <i>a1</i>	P53	18 <i>h</i>	$14.5 \pm 0.35$	$1470 \pm 820$	cf. 7-14 <i>a1</i>	$\text{Gd}_2\text{O}_3$
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64-160 <i>a2</i>	W60 I	$18 \pm 0.3h^*$	$14.8 \pm 0.8$	$1450 \pm 300$	cf. 13-27 <i>b4</i>	$\text{Gd}_2\text{O}_3$ enriched : $\text{Gd}^{160}: 95.3\%$ ; thick- ness 50-200 mg/cm <sup>2</sup>
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64-160 <i>a3</i>	K61 II	17.4 <i>h</i>	$14.8 \pm 0.5$	$1725 \pm 170$	cf. 17-35 <i>a5m</i>
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$\text{Gd}^{160}(n, \alpha) \text{ Sm}^{157}$

64-160 <i>i1</i>	W60 I	$0.5 \pm 0.1 \text{ min}^*$	$14.8 \pm 0.8$	$2 \pm 1$	cf. 13-27 <i>b4</i>	cf. 64-160 <i>a2</i>
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\* Measured by the authors

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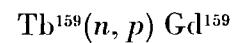
VI

VII

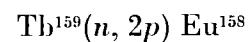
VIII

IX

## T E R B I U M



65-159 <i>b</i> 1	B61 VI	—	14.8	$\sim 2.2$	—	—	—	—
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65-159 <i>h</i> 1	B62 II	60 min	14.7	$< 0.080$	—	—	—	—
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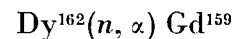
VI

VII

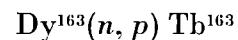
VIII

IX

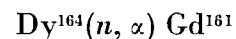
## DYSPROSIUM



66-162i1	C59 II	—	14.5	$3.56 \pm 0.36$	cf. 49-115i2
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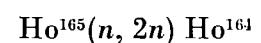
66-163b1	W60 I	$7 \pm 1$ min*	$14.8 \pm 0.8$	$3 \pm 1$	cf. 13-27b4	Element,purity 98% thickness 80 mg/cm <sup>2</sup> . $\text{Dy}^{163}$ enriched 74%; thickness 35 mg/cm
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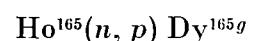
66-164i1	W60 I	$3.7 \pm 0.3$ min*	$14.8 \pm 0.8$	$4.5 \pm 0.8$	cf. 27-59alg	cf. 66-163b1
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\* Measured by the authors

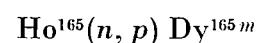
## H O L M I U M



67-165a1	K61 II	38.5 min	14.8 $\pm$ 0.5	2100 $\pm$ 210		cf. 17-35a5m
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67-165b1g	F61 II	—	14.1 $\pm$ 0.2	40 $\pm$ 10		cf. 13-27b11
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67-165b1m	F61 II	—	14.1 $\pm$ 0.2	$< 1$		cf. 13-27b11
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## E R B I U M

### $\text{Er}^{166}(n, 2n) \text{ Er}^{165}$

68-166a1	W60 I	$10 \pm 1 h^*$	$14.8 \pm 0.8$	$1000 \pm 400$	cf. 27-59alg	Element, purity $> 98\%$ ; thickness 50-180mg/cm <sup>2</sup> ; $\text{Er}_2\text{O}_3$ enriched $\text{Er}^{168}$ : 76.9%; $\text{Er}^{172}$ : 87.3%; thickness 35 mg/cm <sup>2</sup>
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### $\text{Er}^{167}(n, p) \text{ Ho}^{167}$

68-167b1	W60 I	$3.1 \pm 0.1 h^*$	$14.8 \pm 0.8$	$3 \pm 1$	cf. 27-59alg	cf. 68-166a1
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### $\text{Er}^{168}(n, p) \text{ Ho}^{168}$

68-168b1	W60 I	$3.3 \pm 0.5 \text{ min}^*$	$14.8 \pm 0.8$	$2.5 \pm 1$	cf. 27-59alg	cf. 68-166a1
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### $\text{Er}^{168}(n, \alpha) \text{ Dy}^{165g}$

68-168ilg	W60 I	$140 \pm 5 \text{ min}^*$	$14.8 \pm 0.8$	$0.5 \pm 0.2$	cf. 27-59alg	cf. 68-166a1
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### $\text{Er}^{168}(n, \alpha) \text{ Dy}^{165m}$

68-168ilm	W60 I	$1.3 \pm 0.2 \text{ min}^*$	$14.8 \pm 0.8$	$1 \pm 0.2$	cf. 27-59alg	cf. 68-166a1
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### $\text{Er}^{170}(n, 2n) \text{ Er}^{169}$

68-170a1	W60 I	$9.8 \pm 0.5 d^*$	$14.8 \pm 0.8$	$1200 \pm 500$	cf. 27-59alg	cf. 68-166a1
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### $\text{Er}^{170}(n, p) \text{ Ho}^{170}$

68-170b1	W60 I	$40 \pm 10 \text{ sec}^*$	$14.8 \pm 0.8$	$1.8 \pm 0.5$	cf. 27-59alg	cf. 68-166a1
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### $\text{Er}^{170}(n, \alpha) \text{ Dy}^{167}$

68-170i1	W60 I	$4.4 \pm 0.4 \text{ min}^*$	$14.8 \pm 0.8$	$1.0 \pm 0.2$	cf. 27-59alg	cf. 68-166a1
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\* Measured by the authors

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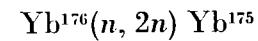
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## Y T T E R B I U M



70-176a1	W60 I	$4.2 \pm 0.2d^*$	$14.8 \pm 0.8$	$430 \pm 100$	cf. 13-27b4	Element, thickness 40 mg/cm <sup>2</sup>
70-176a2	K61 II	$99h$	$14.8 \pm 0.5$	$786 \pm 80$	cf. 17-35a5m	

\* Measured by the authors

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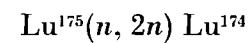
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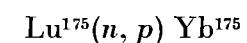
IX

## L U T E T I U M



71-175a1	W60 I	$14.8 \pm 0.8$	$1600 \pm 300$	
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cf. 27-59alg



17-175b1	C59 II	—	$14.5$	$3\ 42 \pm 0.51$	
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cf. 49-115i2

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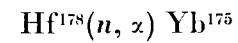
VI

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**H A F N I U M**



72-178*i1*

C59 II

—

14.5

$2.0 \pm 0.2$

cf. 49-115*i2*

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## T A N T A L U M

### $\text{Ta}^{181}(n, 2n) \text{ Ta}^{180}$ - tot.

73-181a1t	A58 II	—	14.1	$2640 \pm 200$	cf. 1-2a1	Element
73-181a2t diff.	R57	—	14.1	$1800 \pm 300$ for $E_n > 0.5$ MeV; $d\Omega = 4\pi$	cf. 4-9a2	

### $\text{Ta}^{181}(n, 2n) \text{ Ta}^{180m}$

73-181a1m	P61 I	8.15h	13.88 $\pm$ 0.10*	1118 $\pm$ 56	cf. 22-46a2	Element
			14.09 $\pm$ 0.10	1132 $\pm$ 56		
			14.31 $\pm$ 0.13	1115 $\pm$ 56		
			14.50 $\pm$ 0.20	1116 $\pm$ 56		
			14.68 $\pm$ 0.26	1087 $\pm$ 55		
73-181a2m	P53	8h	14.5 $\pm$ 0.35	867 $\pm$ 220	cf. 7-14a1	Element
73-181a3m	P60 II	8h	14.8 $\pm$ 0.8	2740 $\pm$ 30	cf. 50-120b1	

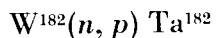
### $\text{Ta}^{181}(n, p) \text{ Hf}^{181}$

73-181b1	S59 IV	—	14	$2.5 \pm 0.3$	—	—	—
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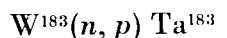
\* Also measured for  $12.1 \text{ MeV} \leq E_n \leq 19.8 \text{ MeV}$

I	II	III	IV	V	VI	VII	VIII	IX
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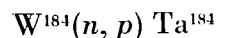
## T U N G S T E N



74-182b1	S59 IV	—	14	$2.3 \pm 0.2$	—	—	—	—
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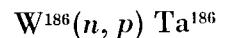


74-183b1	S59 IV	—	14	$2.8 \pm 0.3$	—	—	—	—
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74-184b1	C59 II	—	14.5	$4.75 \pm 0.95$	cf. 49-115i2	—	—	—
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74-184b2	P61 IV	—	14.8	$14 \pm 4$	—	—	—	—
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74-186b1	C59 II	—	14.5	$2.9 \pm 0.6$	cf. 49-115i2	—	—	—
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74-186b2	P61 IV	—	14.8	$11 \pm 4$	—	—	—	—
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74-186b3	B59 II	—	$13.7 \pm 0.25^*$	$1.0 \pm 0.2$	cf. 52-128e1	—	—	—
			$14.5 \pm 0.3$	$1.4 \pm 0.3$				
			$14.85 \pm 0.15$	$2.8 \pm 0.5$				



74-186c1	B59 II	—	$13.7 \pm 0.25^*$	$< 0.04$	cf. 52-128e1	—	—	—
			$14.5 \pm 0.3$	$0.11 \pm 0.05$				
			$14.85 \pm 0.15$	$0.3 \pm 0.15$				

\* Also measured for  $18.0 \text{ MeV} \leq E_n \leq 21.2 \text{ MeV}$

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## R H E N I U M

$\text{Re}^{187}(n, 2n) \text{ Re}^{186}$

75-187 <i>a</i> 1	K61 II	<i>89.0h</i>	$14.8 \pm 0.5$	$1675 \pm 168$	
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cf. 17-35*a*5*m*

$\text{Re}^{187}(n, p) \text{ W}^{187}$

75-187 <i>b</i> 1	C59 II	<i>—</i>	<i>14.5</i>	$3.93 \pm 0.4$	
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cf. 49-115*i*2

$\text{Re}^{187}(n, \alpha) \text{ Ta}^{184}$

75-187 <i>i</i> 1	C59 II	<i>—</i>	<i>14.5</i>	$0.94 \pm 0.14$	
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cf. 49-115*i*2

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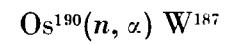
V

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VII

VIII

IX

**O S M I U M**76-190*i1*

C59 II

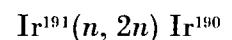
—

14.5

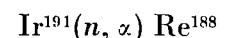
 $0.57 \pm 0.09$ cf. 49-115*i2*

I	II	III	IV	V	VI	VII	VIII	IX
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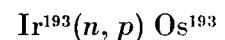
## I R I D I U M



7-191 <i>a</i> 1	K61 II	3.1 <i>h</i>	$14.8 \pm 0.5$	$367 \pm 55$		cf. 17-35 <i>a</i> 5 <i>m</i>	
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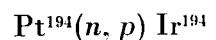
77-191 <i>i</i> 1	C59 II	—	14.5	$2.43 \pm 0.22$		cf. 49-115 <i>i</i> 2	
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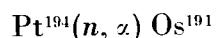
77-193 <i>b</i> 1	C59 II	—	14.5	$2.7 \pm 0.5$		cf. 49-115 <i>i</i> 2	
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I	II	III	IV	V	VI	VII	VIII	IX
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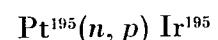
## P L A T I N U M



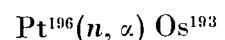
78-194 <i>b1</i>	C59 II	—	14.5	$3.92 \pm 0.4$		cf. 49-115 <i>i2</i>	
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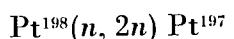
78-194 <i>i1</i>	C59 II	—	14.5	$1.26 \pm 0.25$		cf. 49-115 <i>i2</i>	
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78-195 <i>b1</i>	C59 II	—	14.5	$2.91 \pm 0.3$		cf. 49-115 <i>i2</i>	
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78-196 <i>i1</i>	C59 II	—	14.5	$0.55 \pm 0.11$		cf. 49-115 <i>i2</i>	
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78-198 <i>a1</i>	P53	—	$14.5 \pm 0.35$	$2770 \pm 1500$		cf. 7-14 <i>a1</i>	Element
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I	II	III	IV	V	VI	VII	VIII	IX
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## G O L D

### $\text{Au}^{197}(n, 2n) \text{ Au}^{196}$ - tot.

79-197a1t	P53	5.5d	14.5 $\pm$ 0.35	1722 $\pm$ 460		cf. 7-14a1		Element
79-197a2t	A58 II	—	14.1	2600 $\pm$ 200		cf. 1-2a1		Element
79-197a3t	T60	—	13.9* <sup>1</sup> 14.0 14.1 14.6 15.1	1960 1900 2110 2090 2110	—	—	—	—
79-197a4t	P61 I	6.06d* <sup>3</sup>	14.01 $\pm$ 0.10* <sup>2</sup> 14.31 $\pm$ 0.13 14.50 $\pm$ 0.20 14.81 $\pm$ 0.31	2403 $\pm$ 120 2420 $\pm$ 120 2403 $\pm$ 120 2356 $\pm$ 120	cf. 22-46a2	cf. 79-197alm	cf. 22-46a2	

### $\text{Au}^{197}(n, 2n) \text{ Au}^{196m}$

79-197a1m	P61 I	9.83h	14.01 $\pm$ 0.10* <sup>2</sup> 14.31 $\pm$ 0.13 14.50 $\pm$ 0.20 14.81 $\pm$ 0.31	134.3 $\pm$ 6.7 137.1 $\pm$ 6.9 142.1 $\pm$ 7.1 145.1 $\pm$ 7.3	cf. 22-46a2	$\gamma$ -activity ; calibrated NaI crystal	cf. 22-46a2	
79-197a2m	T60	—	13.9* <sup>4</sup> 14.0 14.1 14.6 15.1	165 165 195 210 195	—	—	—	—

### $\text{Au}^{197}(n, p) \text{ Pt}^{197}$

79-197b1	C59 II	—	14.5	2.42 $\pm$ 0.24	cf. 49-115i2
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\*<sup>1</sup> Also measured for 8.2 MeV  $\leq E_n \leq$  15.1 MeV

\*<sup>2</sup> Also measured for 12.1 MeV  $\leq E_n \leq$  19.8 MeV

\*<sup>3</sup> Measured by the authors

\*<sup>4</sup> Also measured for 9.4 MeV  $\leq E_n \leq$  15.1 MeV

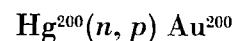
I	II	III	IV	V	VI	VII	VIII	IX
79-197 <i>b2</i>	P61 IV	—	14.01 $\pm$ 0.10* <sup>1</sup> 14.09 $\pm$ 0.10 14.31 $\pm$ 0.13 14.50 $\pm$ 0.20 14.68 $\pm$ 0.26 14.81 $\pm$ 0.31 14.93 $\pm$ 0.36	1.8 $\pm$ 0.1 2.0 $\pm$ 0.1 2.0 $\pm$ 0.1 2.2 $\pm$ 0.1 2.6 $\pm$ 0.1 2.4 $\pm$ 0.1 2.6 $\pm$ 0.1		cf. 22-46 <i>a2</i>		
79-197 <i>f1</i>	B62 II		14.7	< 0.020	—	—	—	—
					Au <sup>197</sup> (n, He <sup>3</sup> ) Ir <sup>195</sup>			
79-197 <i>i1</i>	P61 IV	—	14.01 $\pm$ 0.10* <sup>2</sup> 14.09 $\pm$ 0.10 14.31 $\pm$ 0.13 14.50 $\pm$ 0.20 14.68 $\pm$ 0.26 14.81 $\pm$ 0.31 14.93 $\pm$ 0.36	0.27 $\pm$ 0.02 0.27 $\pm$ 0.02 0.28 $\pm$ 0.02 0.35 $\pm$ 0.02 0.38 $\pm$ 0.02 0.46 $\pm$ 0.02 0.44 $\pm$ 0.02		cf. 22-46 <i>a2</i>		
79-197 <i>i2</i>	C59 II	—	14.5	0.43 $\pm$ 0.04		cf. 49-115 <i>i2</i>		
					Au <sup>197</sup> (n, n $\alpha$ ) Ir <sup>193</sup>			
79-197 <i>k1</i>	B62 II	12 <i>d</i>	14.7	< 1.5	—	—	—	—

\*<sup>1</sup> Also measured for 12.1 MeV  $\leq$  E<sub>n</sub>  $\leq$  19.6 MeV

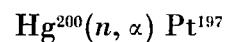
\*<sup>2</sup> Also measured for 7 MeV and 12.1 MeV  $\leq$  E<sub>n</sub>  $\leq$  19.8 MeV

I	II	III	IV	V	VI	VII	VIII	IX
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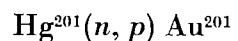
### M E R C U R Y



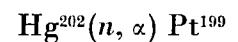
80-200 <i>b</i> 1	C59 II	—	14.5	$3.63 \pm 0.36$		cf. 49-115 <i>i</i> 2
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80-200 <i>i</i> 1	C59 II	—	14.5	$1.77 \pm 0.35$		cf. 49-115 <i>i</i> 2
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80-201 <i>b</i> 1	C59 II	—	14.5	$2.12 \pm 0.32$		cf. 49-115 <i>i</i> 2
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80-202 <i>i</i> 1	C59 II	—	14.5	$1.01 \pm 0.10$		cf. 49-115 <i>i</i> 2
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I	II	III	IV	V	VI	VII	VIII	IX
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## T H A L L I U M

### $Tl^{203}(n, 2n) Tl^{202}$

81-203a1	P61 I	<i>12.5d</i>	13.88 $\pm$ 0.10* <sup>1</sup>	1302 $\pm$ 58				
			14.09 $\pm$ 0.10	1302 $\pm$ 58				
			14.31 $\pm$ 0.13	1329 $\pm$ 60				
			14.50 $\pm$ 0.20	1321 $\pm$ 60				
			14.68 $\pm$ 0.26	1305 $\pm$ 58				
81-203a2	T60	—	13.9* <sup>2</sup>	1450	—	—	—	—
			14.0	1460				
			14.6	1560				
			15.1	1650				
81-203a3	M52		Rel. measurement* <sup>3</sup>			cf. 19-63a12		

### $Tl^{203}(n, p) Hg^{203}$

81-203b1	P61 IV	—	14.8	30	—	—	—	—
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### $Tl^{203}(n, \alpha) Au^{200}$

81-203i1	C59 II	—	14.5	0.37 $\pm$ 0.04		cf. 49-115i2		
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### $Tl^{203}(n, n\alpha) Au^{199}$

81-203k1	B62 II	<i>3.15d</i>	14.7	< 0.012	—	—	—	—
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### $Tl^{205}(n, p) Hg^{205}$

81-205b1	P53	6 min	14.5 $\pm$ 0.35	3.05 $\pm$ 0.6		cf. 7-14a1		Element
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81-205b2	C59 II	—	14.5	6.8 $\pm$ 0.7		cf. 49-115i2		
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81-205b3	P61 IV	—	14.8	3.0 $\pm$ 0.3	—	—	—	—
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### $Tl^{205}(n, He^3) Au^{203}$

81-205f1	B62 II	55 sec	14.7	< 0.010	—	—	—	—
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\*<sup>1</sup> Also measured for 12.3 MeV  $\leq E_n \leq$  19.8 MeV

\*<sup>2</sup> Also measured for 8.4 MeV  $\leq E_n \leq$  15.1 MeV

\*<sup>3</sup> Also measured for 12 MeV  $\leq E_n \leq$  18.5 MeV

I

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III

IV

V

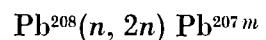
VI

VII

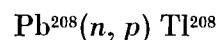
VIII

IX

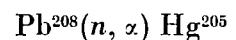
## L E A D



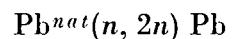
82-208a1m	G61 I	$0.81 \pm 0.02$ sec*	14.5	$1700 \pm 300$	rel.: cf. 29-63a $\text{Cu}^{63}(n, 2n) = 620$ mb	cf. 12-24b1m
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82-208b1	P53	3.1 min	$14.5 \pm 0.35$	$0.96 \pm 0.96$	cf. 7-14a1	Element
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82-208i1	C59 II	—	14.5	$1.58 \pm 0.27$	cf. 49-115i2
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82-a1	A58 II	—	14.1	$2740 \pm 200$	cf. 1-2a1	Element
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\* Measured by the authors

## B I S M U T H

### $\text{Bi}^{209}(n, 2n) \text{ Bi}^{208}$ - tot.

							Element
83-209a1t	A58 II	—	14.1	$2600 \pm 200$		cf. 1-2a1	
83-209a2t	R57	—	14.1	$2300 \pm 300$ for $E_\eta \sim 0.5$ MeV: $d\Omega$ $\approx 4\pi \text{ Bi}^{209}(n, 2n) \text{ Bi}^{208m}$		cf. 4-9a2	
83-209a1m	G61 I	$2.6 \pm 0.1$ msec*	14.5	$660 \pm 120$	rel.: cf. 29-63a $\text{Cu}^{63}(n, 2n) \quad 620$ mb	cf. 12-24b1m	

### $\text{Bi}^{209}(n, p) \text{ Pb}^{209}$

83-209b1	P59 I	$3.31 \pm 0.03h^*$	$14.8 \pm 0.8$	$0.83 \pm 0.40$		cf. 13-27b4	Element, thickness 34-56 mg/cm <sup>2</sup>
83-209b2	C59 II	—	14.5	$1.33 \pm 0.26$		cf. 49-115i2	
83-209b3	M61 II	—	14.8	$0.7 \pm 0.1$		cf. 11-23i2	

### $\text{Bi}^{209}(n, z) \text{ Tl}^{206}$

83-209i1	P53	4 min	$14.5 \pm 0.35$	$1.2 \pm 1.0$		cf. 7-14a1	$\text{Bi}_2\text{O}_3$ ; Element
83-209i2	P59 I	$4.29 \pm 0.05$ min*	$14.8 \pm 0.8$	$1.1 \pm 0.3$		cf. 13-27b4	Element, discs, thick- ness 34-56 mg/cm <sup>2</sup>
83-209i3	C59 II	—	14.5	$0.52 \pm 0.08$		cf. 49-115i2	
83-209i4	M61 II	—	14.8	$0.6 \pm 0.1$		cf. 11-23i2	

\* Measured by the authors

## T H O R I U M

### Th<sup>230</sup>(n, $\alpha$ ) Ra<sup>227</sup>

90-230 <i>i</i> 1	C59 II	—	14.5	$4.5 \pm 1.1$	rel. : Al <sup>27</sup> (n, $\alpha$ ) = ?	$\beta$ -activity, $2\pi$ geometry ; prop. counter ; chem. se- paration. Calibration by measurements in $4\pi$ geo- metry	Mean error contains : statistics, neutron flux chem. separation	—
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### Th<sup>232</sup>(n, 2n) Th<sup>231</sup>

90-232 <i>a</i> 1	P61 I	26.64 <i>h</i>	13.88 ± 0.10* <sup>1</sup> 14.09 ± 0.10 14.31 ± 0.13 14.50 ± 0.20 14.68 ± 0.26 14.81 ± 0.31 14.93 ± 0.36	1580 ± 158 1560 ± 156 1520 ± 152 1440 ± 144 1400 ± 140 1280 ± 128 1255 ± 125	—	cf. 22-46 <i>a</i> 2	—	—
90-232 <i>a</i> 2	T60	—	13.9* <sup>2</sup> 14.0 14.6 15.1	1490 1330 1400 980	—	—	—	—
90-232 <i>a</i> 3	Z61	—	14.7	650 ± 150	rel. : $\sigma(\text{U}^{238}\text{fiss.}) = 1.16$	$\beta$ -activity, $4\pi$ geometry. Chem. separation	Error contains : $\sigma(\text{U}^{238}$ Th( $\text{NO}_3$ ) <sub>4</sub> .4H <sub>2</sub> O fiss.); statistics	—
90-232 <i>a</i> 4	D59 VII	—	14.45 ± 0.20	1230 ± 60	rel. : cf. 16-32 <i>b</i> 2 $S^{22}(n, p) = 229$ mb Sandwich method	$\beta$ -activity; chem. sepa- ration	Error contains : sta- tistics; calibration	Metal discs of 3/16" Ø and 0.040" thick- ness
90-232 <i>a</i> 5	P61 VIII	—	14.5 ± 0.5	1200 ± 50	rel. : cf. 13-27 <i>i</i> Al <sup>27</sup> (n, $\alpha$ ) = ?	$\gamma$ -activity 2 1/2" × 2 1/2" NaI crystal. Calibration with standard sources	Error contains : sta- tistics 1%; calibra- tion 3%: neutron flux 3%; weight of the target 1%	Oxyd, 2 cm <sup>2</sup> , 8.35 mg/cm <sup>2</sup>

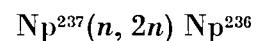
\*<sup>1</sup> Also measured for 12.2 MeV ≤ E<sub>n</sub> ≤ 16.5 MeV

\*<sup>2</sup> Also measured for 8.2 MeV ≤ E<sub>n</sub> ≤ 15.1 MeV

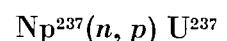
I	II	III	IV	V	VI	VII	VIII	IX
<b>U R A N I U M</b>								
<b><math>U^{235}(n, p) Pa^{235}</math></b>								
92-235b1	C59 II	—	14.5	$1.86 \pm 0.37$		cf. 20-230i1		
<b><math>U^{238}(n, 2n) U^{237}</math></b>								
92-238a1	P61 VIII	—	$14.5 \pm 0.4$	$690 \pm 40$	rel. : cf. 29-65a $Cu^{65}(n, 2n) = ?$	cf. 90-232a5	Error contains : neutron flux 5 % ; thick source correction 2 % ; weight of the targ. 1 % ; calibration 2 %	Oxyd 275 mg
<b><math>U^{238}(n, \alpha) Th^{235}</math></b>								
92-238i1	C59 II	—	14.5	$1.5 + 0.3$		cf. 90-230i1		

I            II            III            IV            V            VI            VII            VIII            IX

N E P T U N I U M



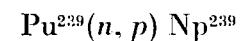
93-237a1      P61 VIII     $2.7 \pm 0.3y$        $14.5 \pm 0.4$        $390 \pm 40$       —      Counting of the  $\alpha$  of Pu<sup>236</sup>      —      Dioxyde 72 mg



93-237b1      C59 II      —      14.5       $1.3 \pm 0.3$       cf. 90-230i1

I            II            III            IV            V            VI            VII            VIII            IX

## PLUTONIUM



94-239*b1*        C59 II        —        14.5         $3.0 \pm 0.5$         .        ct 90-230*i1*



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